ECHNOLOGY DEPT.

TECHNOLOGY REVIEW

February 1953

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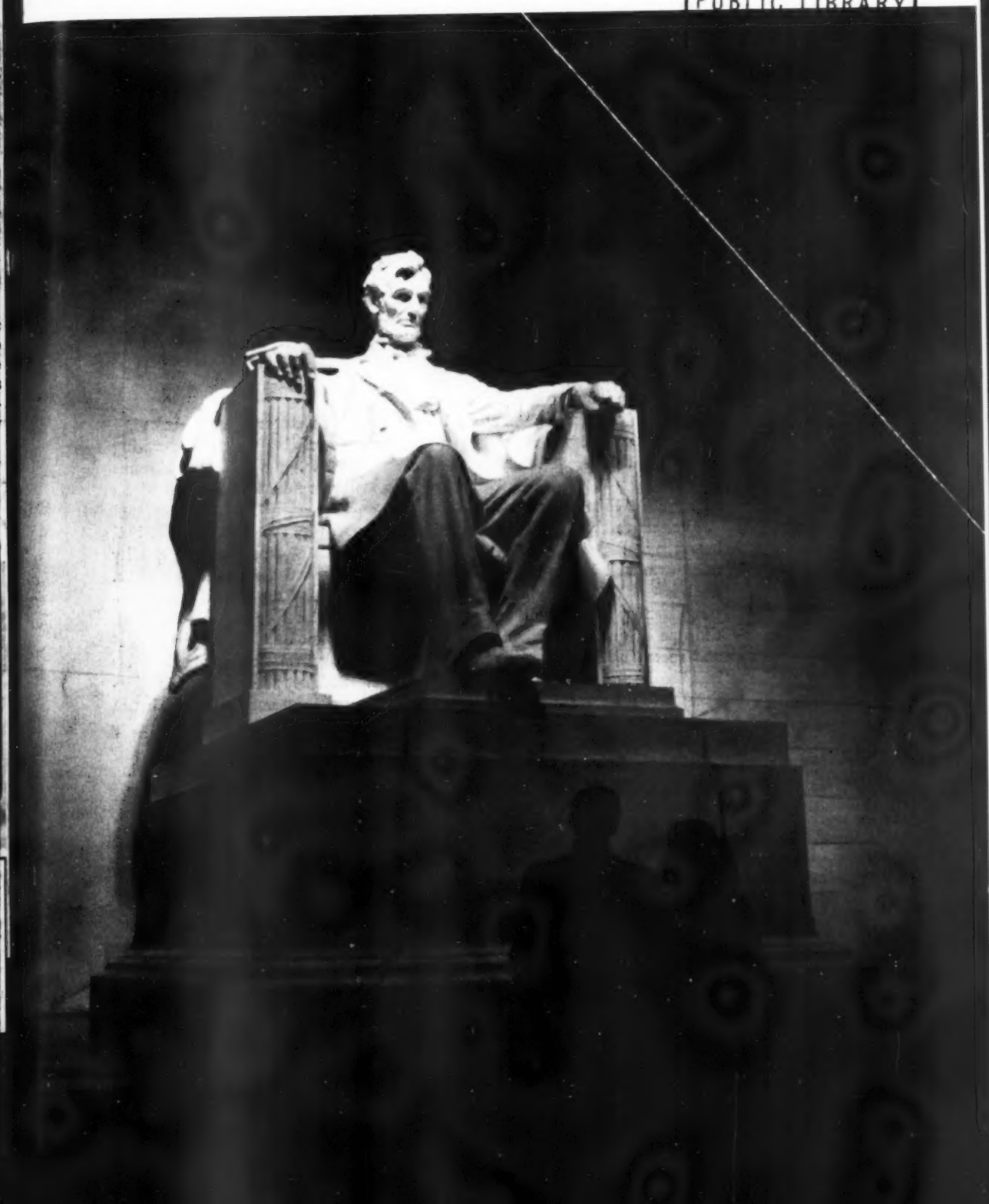

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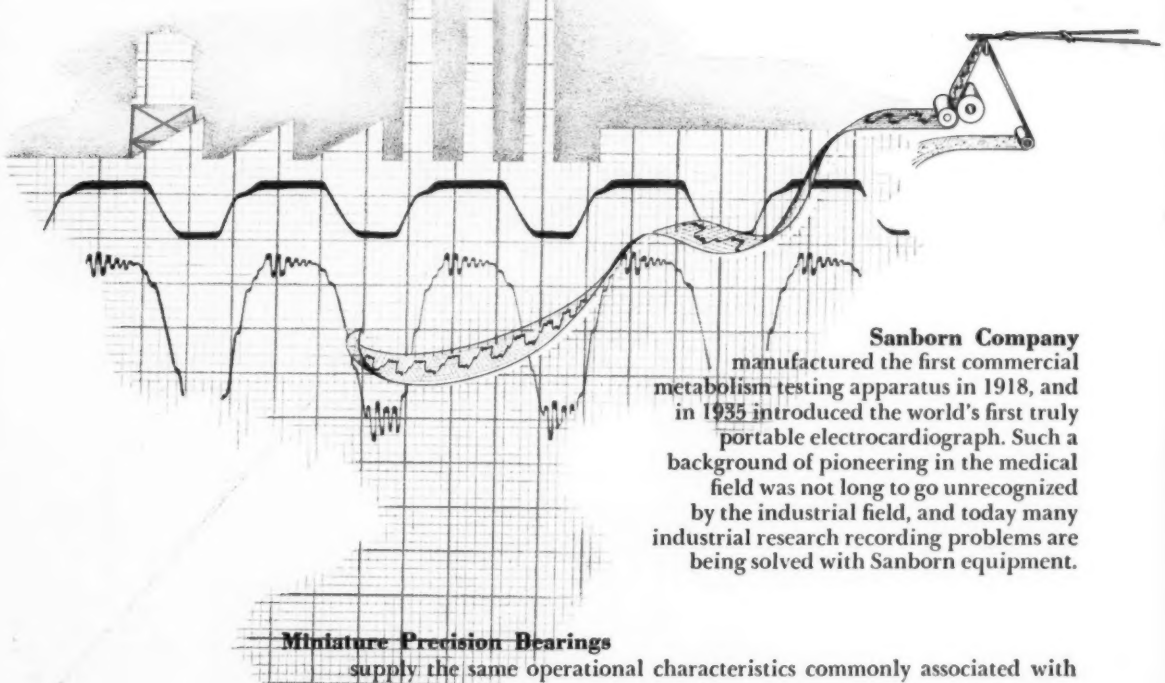
Pioneers in Precision



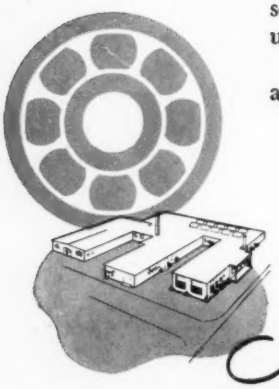
Sanborn Company manufactured the first commercial metabolism testing apparatus in 1918, and in 1935 introduced the world's first truly portable electrocardiograph. Such a background of pioneering in the medical field was not long to go unrecognized by the industrial field, and today many industrial research recording problems are being solved with Sanborn equipment.

Miniature Precision Bearings

supply the same operational characteristics commonly associated with larger prototypes. Wherever design problems concerning unusual operating conditions are present . . . extreme temperature . . . shock . . . continuous high load capacity . . . limited space in instrument miniaturization projects . . . **MPB** ball bearings supply a vital need.

For more than 20 years, the originators and pioneer developers of ball bearings in this size range (1/10″ to 5/16″ o.d.), **MPB** supplies ultra quality miniature ball bearings to more than three thousand discriminating users. Exclusive and exacting production procedures – including full grinding, lapping, honing and/or burnishing to ABEC 5 tolerances or better – result in the type of quality which permits installation of these ball bearings in control and recording instruments of highest possible performance standards. **MPB** ball bearings are torque tested, ultrasonicly cleaned, supplied in specific clearances, and classified within the tolerances for prompt assembly and maximum service. More than a million **MPB** ball bearings have been installed in many unusual and distinctive devices.

The most extensive engineering knowledge in miniature ball bearing application is available to you. Also request Catalog and survey sheet TR2



Through extensive expansion, the production of these ultra quality bearings has been considerably increased. However; the continuing trend toward miniaturization, plus a constant demand for better quality bearings, has temporarily limited an immediate supply. Further expansion will soon enable us to serve you promptly.

Miniature *precision* Bearings

Incorporated MPB Keene, New Hampshire

"pioneer precisionists to the World's foremost instrument manufacturers"

save
space
weight
friction

Lifting words off newsprint

How precise can modern grinding be?

So precise that in demonstration the newsprint can be ground from one side of a news page without disturbing the paper itself or the newsprint on the other side. The printed surface is removed with a Behr-Manning coated abrasive drum cover. A roll, precision ground with Norton abrasive grinding wheels, holds the paper in exact position to a fraction of a "hair's breadth" during the grinding process.

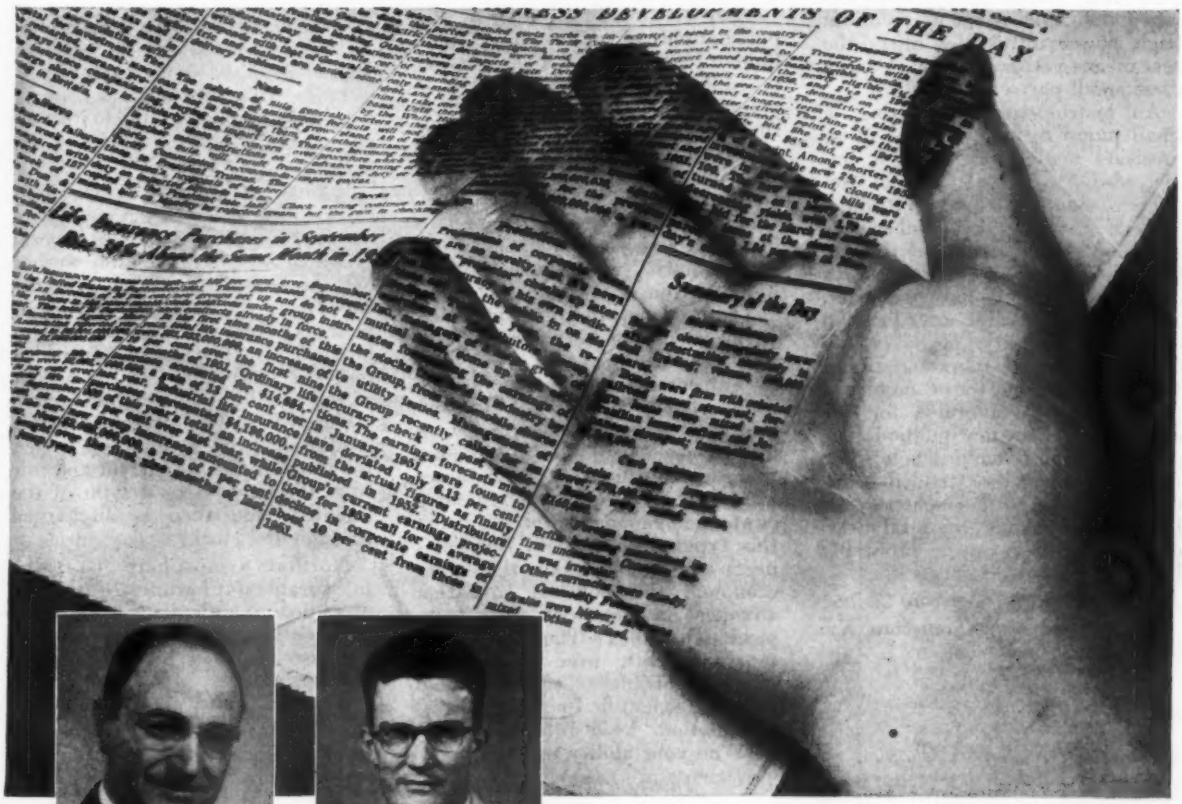
Coated abrasives by Behr-Manning and grinding wheels and abrasives by Norton are performing grinding "miracles" vital to the performance of such products as jet planes, your automobile, your refrigerator and other home appliances.

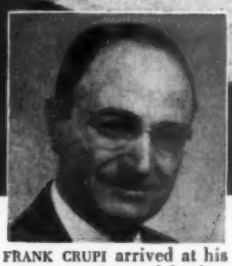
Many of today's finest products would not have been economically possible but for Norton and Behr-Manning abrasive products. These products add value to every product they touch.

***NORTON COMPANY** makes abrasives, grinding wheels, pulpstones, refractories, grinding and lapping machines, non-slip floors, Norbide grain and molded products. Norton Company, Main Office and Works, Worcester 6, Mass.*

***BEHR-MANNING** makes abrasive paper and cloth, oilstones, abrasive specialties, pressure-sensitive tapes. Behr-Manning Corporation, Division of Norton Company, Troy, New York.*

Plants, Distributors and Dealers the world over





FRANK CRUPI arrived at his present position of Quality Control Manager for Behr-Manning the know-how way. He has made many original improvements in the company's coated abrasives over the past 37 years.

OSGOOD J. WHITTEMORE, Norton Ceramic Research Engineer since 1945, noted for his work in developing pure oxide refractories such as Fused Stabilized Zirconia which can withstand temperatures up to 4700° F.

NORTON

BEHR-MANNING

Making better products to make other products better

NORTON · BEHR-MANNING

THE TECHNOLOGY REVIEW, February, 1953, Vol. LV, No. 4. Published monthly from November to July inclusive at Emmett Street, Bristol, Conn. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription, $4.00. Entered as second-class matter December 23, 1949, at the Post Office at Bristol, Conn., under the Act of March 3, 1879.

What GENERAL ELECTRIC People Are Saying

G. E. HENRY

General Engineering Laboratory

CLEANING WITH SOUND: It is now some twenty-five years since Wood and Loomis first demonstrated the remarkable physical and chemical effects of high frequency, high power, sound in liquids. People have been busy, during this time, looking for ways to turn these effects to practical advantage, especially in the chemical industry. During the last three or four years, however, the most notable advances have been made not for the chemical producer, but for the metal-working industries—specifically for those engaged in small-parts fabrication. High power ultrasonics offers the best means yet devised for cleaning these small parts.

An instrument ball bearing, a small pump fitting, or some other precision made work piece is immersed in a solvent; a high frequency sound wave beamed through the solvent strikes the metal surface and removes almost instantly any film of oil or grease, together with dirt, chips, or other foreign matter.

There is no longer any question of the superiority of ultrasonic cleaning when the characteristics of the work piece and the economics of production are favorable for the application of the new method. The great question remaining is how far the method can be extended to include different kinds of parts—how large a proportion of the total metal cleaning business can be profitably handled with ultrasonics.

IRE, Evansville—Owensboro Chapter
Owensboro, Ky.

★

W. R. G. BAKER

Electronics Division

ELECTRONICS TOMORROW: Human qualities being what they are, man has always had a great interest in the future.

What electronics will do for us tomorrow, or next year, or 50 years from now depends only partially on the state of the art, or the advancement of our knowledge about electronics. It depends upon what we know about electronics, certainly, but it also depends greatly upon our economic circumstances and our political atmosphere.

Broadly, this is the promise that electronics holds for us. It offers us a means to increase productivity and therefore our standard of living. It offers us quicker and better methods of communications in all areas of industry, commerce, education and entertainment. It offers us a way of making better use of our skills. It offers us a way of bolstering our defenses against aggression.

These promises will not turn into reality automatically and without effort on our part.

They call for investment on our part not only of capital funds but of human resources. We must make it possible for greater numbers of young men and women to receive the education and training that will permit them to participate in this more highly technical civilization and to contribute to its continued growth. We must continue to invest in research, to broaden the basic knowledge on which we can build a stronger economy.

There is one other area in which engineers can make a contribution to the advancement of this country's strength and its future. Science cannot guard against the intellectual germ warfare being carried on by the proponents of the "something-for-nothing-isms." Engineers cannot design electronic devices or atomic weapons to protect against this type of infiltration. But engineers can make certain that their economic and political education advances in step with their technical education. The ability to separate truth from propaganda is as important as the ability to separate scientific fact from misinformation. Your future may depend on your ability to do both.

Institute of Radio Engineers
Washington, D. C.

J. J. FITZGERALD

Knolls Atomic Power Laboratory

SAFETY IN NUCLEAR OPERATIONS: Waste gases as finally discharged into the air, from the Knolls Atomic Power Laboratory at Schenectady, N. Y., are no more radioactive than the normal surrounding atmosphere and in many instances are even less radioactive.

These gases are discharged through a 100-foot stack, and are constantly monitored to make sure that the concentration of radioactive material is kept well below permissible limits.

Constant air monitors are located at selected sites to check the radioactive concentrations at various points near ground level. Plant samples also are analyzed on a regular schedule to evaluate the accumulation of radioactivity on vegetation.

Waste radioactive gases and smokes from the working areas are first passed through a "scrubber," in which a caustic solution washes out the larger radioactive particles as well as the more volatile components. Next they go through a high-efficiency filtering system, which removes more than 99.9 per cent of the small amount of radioactive material left. The air that remains is diluted, from a thousand to ten thousand times, with filtered air from the ventilating system of the building, and then is discharged through the stack.

Normal atmosphere contains measurable but harmless quantities of radioactive elements, and these produce radioactive particles which are also removed by the filtering process.

As a result, in many instances the effluent from our stack is cleaner than the atmosphere itself.

AIEE
New York City

You can put your confidence in—

GENERAL ELECTRIC

ME...
an AIRCRAFT engineer?

But I haven't majored in aeronautical engineering

That doesn't matter. Lockheed can train you... at full pay!

It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager

Lockheed Aircraft Corporation

Burbank, California

This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History

The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

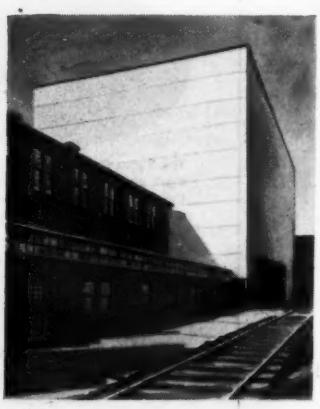
This Plane will make History

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

LOOKING AHEAD WITH Westinghouse

For Westinghouse Electric Corporation, Stone & Webster Engineering Corporation recently made a detailed study of 5 different plans for expansion of the client's electric generator manufacturing capacity.

The work included an independent review of the estimated growth in demand for generators (both hydro and steam) through 1970; determination of the probable maximum economical size of generators; a study of present manufacturing conditions and the capacity desired; a study of methods for increasing manufacturing facilities; description and examination of plans; method of operations under the recommended plan; and a step-by-step program of generator fabrication, with provision for temporary procedures to be followed while the expansion-work is in progress.



First step in expansion of manufacturing facilities at Westinghouse Electric Corporation's plant, East Pittsburgh, Pennsylvania

Stone & Webster Engineering Corporation was subsequently retained to design and build the new facilities.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

42+ *bot grades of Blacks*

Cabot manufactures the world's Greatest Range of CARBON BLACKS

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To manufacture these blacks, Cabot operates many plants, some utilizing natural gas, others liquid hydrocarbon as raw materials. Use of the raw material is dependent upon whether the channel, furnace or thermal process is employed. Development of the oil process of manufacture has made possible the expansion of Cabot plants from the Southwestern part of this country to places distant from natural gas fields—to Sarnia, Ontario, Canada; and to Ellesmere Port, near Liverpool, England.

Cabot blacks give rubber tires the maximum tire mileage so necessary to economical motor travel . . . impart blackness and glossiness so necessary to the successful marketing of many other products.

Cabot has the black to do the specific job required by manufacturers of highest quality or lowest cost articles. Perhaps you, too, should investigate the opportunity for use of a Cabot black in your product.

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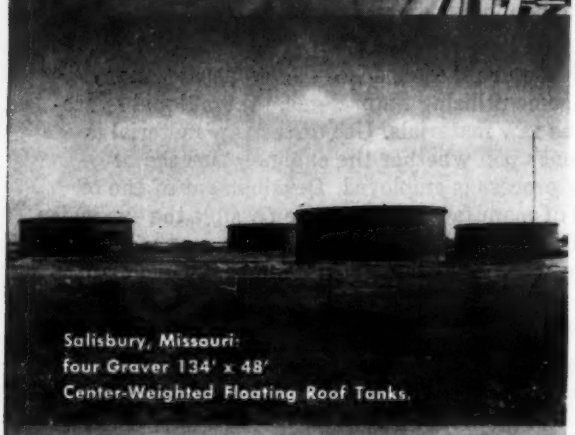
GRAVER CENTER-WEIGHTED FLOATING ROOF TANKS
FOR NEW PLATTE PIPE LINE

Guernsey, Wyoming:
two Graver 100′ x 40′
Center-Weighted Floating Roof Tanks.



Salisbury, Missouri:
four Graver 134′ x 48′
Center-Weighted Floating Roof Tanks.

To provide for corrosion-resistant storage of crudes along its 1056-mile course from Wyoming to Wood River, Ill., the new Platte Pipe Line uses Graver Center-Weighted Floating Roof Tanks at its Guernsey and Gurley injection stations and at its Salisbury pumping station — a total capacity of more than 800,000 barrels.

This new 20-inch line, designed to transport 110,000 b/d from Rocky Mt. fields to refineries, must handle 25 different crudes. Graver's Center-Weighted Floating Roof design — with its inward sloping deck in full contact with the stored crude — assures both the absence of corrosion and the retention of volatile hydrocarbons, since no space exists beneath the single deck for air and vapor to combine and induce corrosion.

GRAVER

Gurley, Nebraska:
one of four Graver 100′ x 40′
Center-Weighted Floating Roof Tanks.

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA
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Nature Controls the Heat in these Schools

James Solomon Russell School, Brunswick County, Va. Total square footage — 67,356. Cost — $524,870. Heating Contractors: W. J. Bloomfield & Son, Inc., Farmville, Va.

Dixon & Norman, Virginia architectural firm specializing in schools, specify Webster Moderator Systems for efficient heat in open-plan buildings fed by long steam lines.

"Nature makes the weather, let her operate the controls" — so say Dixon & Norman, Richmond architects and engineers. For comfort and economy, in all of their larger schools, they use centrally controlled, continuous flow steam heating systems.

"Many of our schools are also used for community activities," Dixon & Norman point out. "Classrooms are larger than average and auditoriums, gymnasiums and shop areas are in separate wings. Despite long steam lines, there is balanced heat distribution because the Moderator System delivers heat evenly and rapidly to every section of a building."

For information about Webster Products for school heating, call the Webster Representative or write us.

Address Dept. TR-2.

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Camden 5, N. J. Representatives in Principal U. S. Cities

In Canada, Darling Brothers, Limited, Montreal

WEBSTER

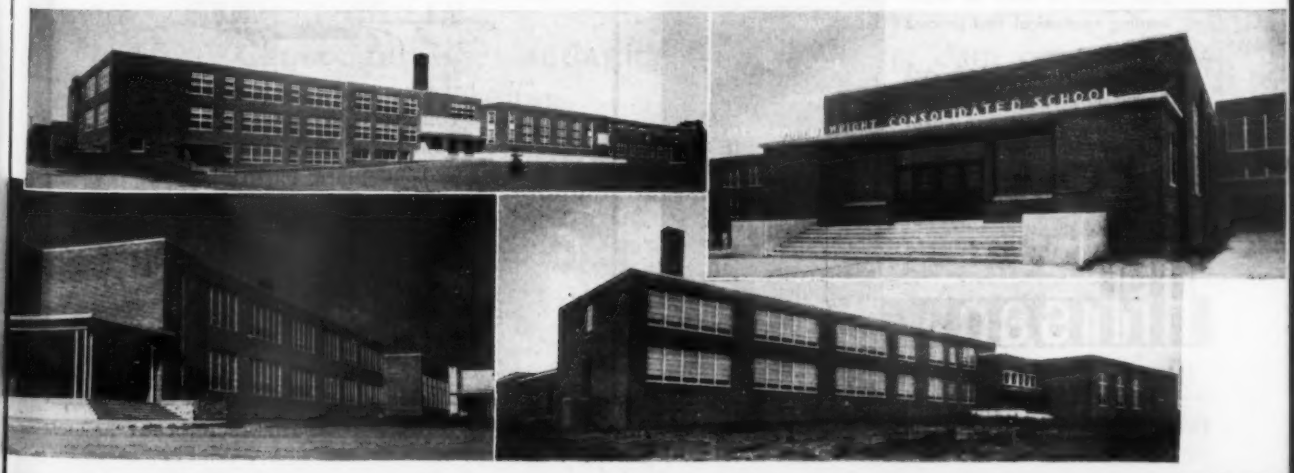
MODERATOR

SYSTEM

OF STEAM HEATING

"Controlled by the weather"

P LEFT: Hermitage High School, Richmond. Heating Contors: W. H. White, Plumbing & Heating, Richmond. TOP HT: John J. Wright School, Spotsylvania County, Va. Heat- Contractors: W. J. Bloomfield & Son, Inc. BOTTOM LEFT: ntevideo High School, Montevideo, Va. Heating Contractors: . Cothran Co., Inc., Altavista, Va. BOTTOM RIGHT: Union h School, Caroline County, Va. Heating Contractors: J. H. hran Co., Inc.



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Artisan METAL PRODUCTS, INC.
73 POND STREET, WALTHAM, (Boston 54) Mass.

THE TABULAR VIEW

Vegetable. — Are all plants closely related in an evolutionary pattern that can be easily followed, or may different plants result from separate creation? The attempt to answer such questions makes an interesting piece of scientific detective work. So, at any rate, states ERNEST C. CROCKER, '14, whose article, "Following a Cold Trial," (page 199) discusses the work of botanists in working over old clues to discover plant relations. Mr. Crocker is a pioneer in the scientific measurement of flavor and odor, and, indeed, has carved out such a name for himself in this field that he is invariably associated with these subjects. But he has also maintained a lifelong interest in botany in which he has also made noteworthy contributions, partly as an avocation and partly as an adjunct to his primary work. Following his graduation from the Institute in 1914, Mr. Crocker held positions as chemist in industry for five years before returning to M.I.T. as a research chemist in applied chemistry. Since 1922 he has been a member of the staff of Arthur D. Little, Inc., a consulting research organization in Cambridge.

Animal. — The human animal is a strange creature. He has made outstanding progress in the mastery of the physical sciences but is conspicuously less able to manage human affairs. Now that the physical sciences have come to play a major role in man's daily life, the man in the street is suddenly called upon to participate in the administration of a national science policy — a task for which he is eminently unsuited. It is the task of scientists, engineers, and science writers to interpret to the layman the philosophy and significance of scientific progress, as JOHN I. MATTILL points out in "Science Publicity — Challenge and Dilemma" (page 203). Mr. Mattill received the B.A. degree from Carleton College in 1943 and the M.A. degree from the

(Concluded on page 190)

"We have never contracted for work with a concern that has shown greater dependability, better methods of economy, speed and quality of performance."
Air Reduction Company

W. J. BARNEY CORPORATION
Founded 1917
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INDUSTRIAL CONSTRUCTION
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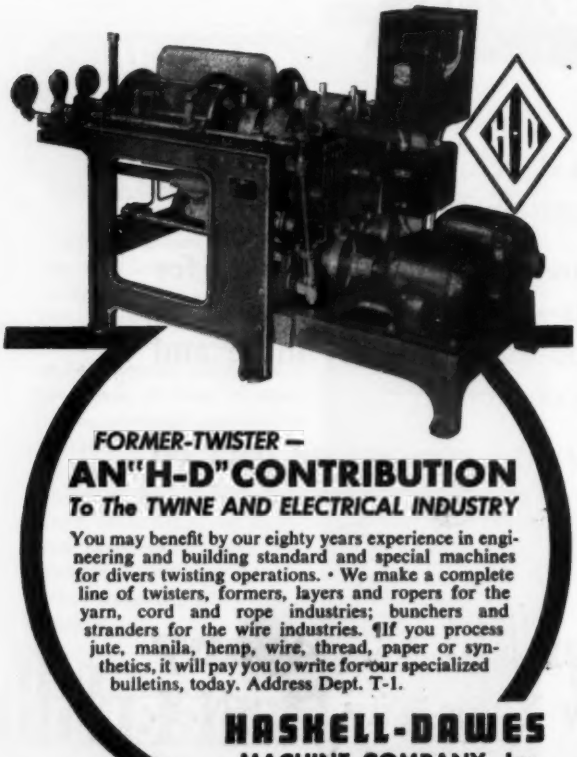

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You may benefit by our eighty years experience in engineering and building standard and special machines for divers twisting operations. • We make a complete line of twisters, formers, layers and ropers for the yarn, cord and rope industries; bunchers and stranders for the wire industries. ¶If you process jute, manila, hemp, wire, thread, paper or synthetics, it will pay you to write for our specialized bulletins, today. Address Dept. T-1.

HASKELL-DAWES

MACHINE COMPANY, Inc.

2231 E. Ontario Street

PHILADELPHIA 34, PA.

THE TABULAR VIEW

(Concluded from page 188)

State University of Iowa in 1948. He was science writer for the State University of Iowa from 1946 to 1948. Mr. Mattill has been assistant director of the M.I.T. News Service since 1948, and in 1952 also became director of publications. The drawings for Mr. Mattill's article were made by Henry B. Kane, '24, Director of the Alumni Fund.

Mineral. — Of all the minerals, gold has been held in the highest esteem by man throughout the ages, for its indestructibility, appearance, desirable physical properties, and its occurrence in nature in nearly pure, metallic form. Untold wars and misery have been caused by man's desire to possess this precious metal, and possession has not always been marked by happiness. The role of gold in civilization is reviewed by metallurgist CARLE R. HAYWARD, '04, Professor of Process Metallurgy, Emeritus, whose article "Gold in Fact, Fiction, and Finance" appears on page 207. Born in Yankton, S.D., Professor Hayward was graduated from M.I.T. in 1904 and spent two years as science instructor at Bellows Free Academy in St. Albans, Vt. He joined the Institute's instructing staff in 1906 and has since been associated with the Department of Metallurgy. He has long been a consultant in his field and has written extensively in the field of metallurgy, particularly on copper, lead, and zinc.

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Promise of a golden future

Yellow uranium ore from the Colorado Plateau is helping to bring atomic wonders to you

Long ago, Indian braves made their war paint from the colorful sandstones of the Colorado Plateau.

THEY USED URANIUM—Their brilliant yellows came from carnotite, the important uranium-bearing mineral. Early in this century, this ore supplied radium for the famous scientists, Marie and Pierre Curie, and later vanadium for special alloys and steels.

Today, this Plateau—stretching over parts of Colorado, Utah, New Mexico, and Arizona—is our chief domestic source of uranium. Here, new communities thrive; jeeps and airplanes replace the burro; Geiger counters supplant the divining rod and miner's hunch.

From hundreds of mines that are often just small tunnels in the hills, carnotite is hauled to processing mills. After the vanadium is extracted, the uranium, concentrated in the form of "yellow-cake," is shipped to atomic energy plants.

A NEW ERA BECKONS—What does atomic energy promise for you? Already radioactive isotopes are working wonders in medicine, industry, and agriculture. In atomic energy, scientists also see a vision of unknown power—which someday may heat and light your home, and propel submarines, ships, and aircraft. The Indian's war paint is on the march again—toward a golden future.

UCC TAKES AN IMPORTANT PART—The people of Union Carbide locate, mine, and refine uranium ore. They also operate for the Government the huge atomic materials plants at Oak Ridge, Tenn., and Paducah, Ky., and the Oak Ridge National Laboratory, where radioisotopes are made.

STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and Plastics. Ask for booklet B-2.*

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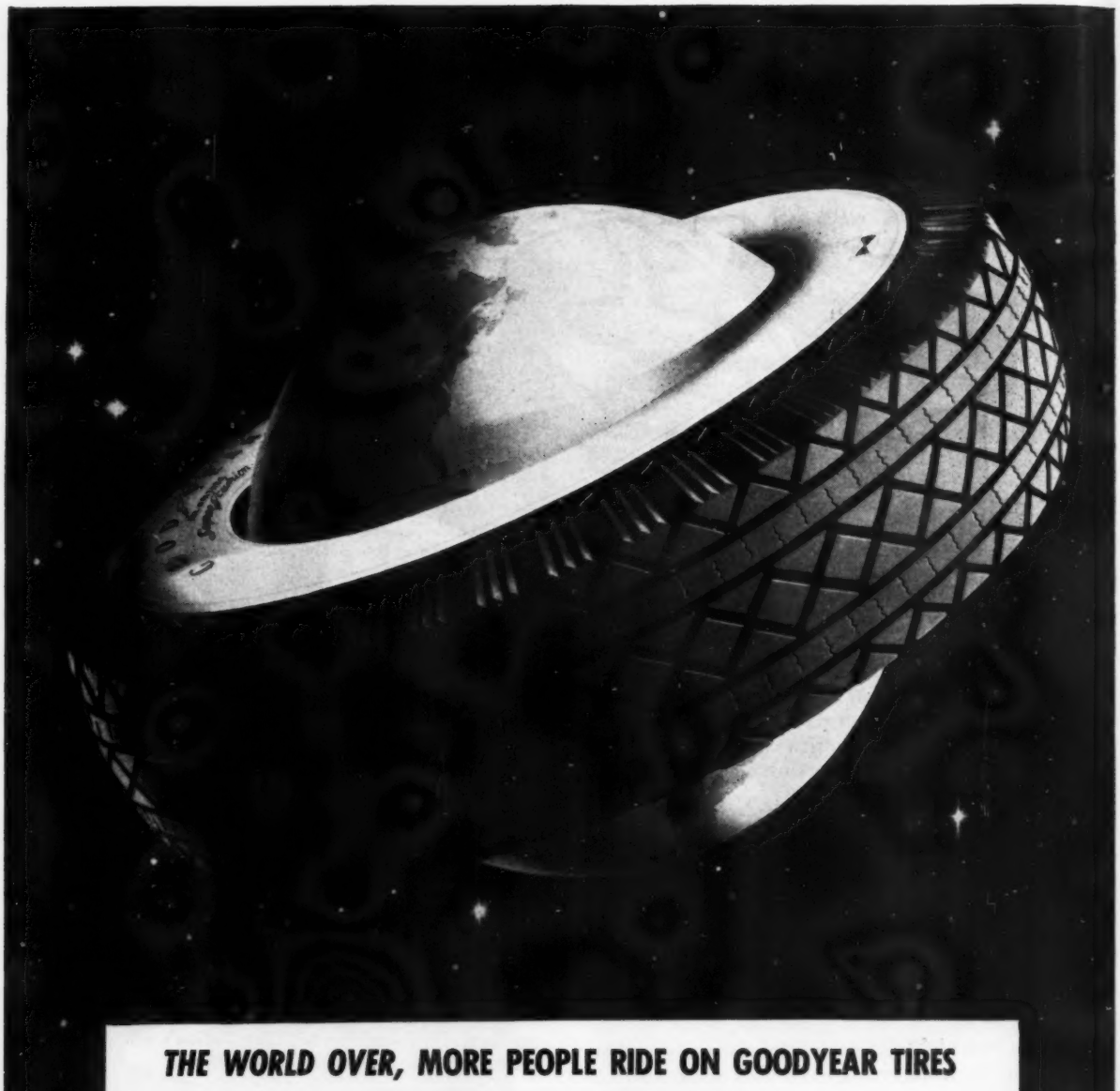

THE WORLD OVER, MORE PEOPLE RIDE ON GOODYEAR TIRES THAN ON ANY OTHER KIND

(Doesn't it stand to reason that the tires that give the most people the greatest satisfaction are the best tires for you to buy?)

GOODYEAR

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M. I. T. Photo

"There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy."
— Shakespeare

THE TECHNOLOGY REVIEW

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Pen Drawing by Sidney L. Kaye, '30 — *Washington Monument, Boston Public Gardens*

"Happily – the Government of the United States, which gives to bigotry no sanction, to persecution no assistance, requires only that they who live under its protection should demean themselves as good citizens, in giving it on all occasions, their effective support."—**George Washington**

THE
TECHNOLOGY
REVIEW

Vol. 55, No. 4 February, 1953

The Trend of Affairs

Lean Horse – Long Race

THE American Public Health Association, at its most recent annual meeting, held a session entitled "America's Number One Public Health Problem." The topic? Obesity! That obesity shortens the life span and increases the incidence of several specific illnesses has been categorically established, not only by animal experiments but also by extensive and reliable statistics on human beings. Indeed overweight has been characterized by one group of experts as a "twilight zone between health and disease."

Obesity is the paradox of modern public health. While improving economic conditions have decreased the incidence of some diseases through better sanitation, less crowded housing, and improved nutrition, higher incomes have *increased* the incidence of obesity by affording the oportunity for overeating, the sole recognized cause of overweight. Hence obesity prevention receives much current emphasis in the educational activities of public health agencies. Also scientific studies of overweight have accelerated and intensified in recent years.

Obesity is usually assessed by comparing weight with height and body structure type, using height-weight tables that have been compiled on the basis of long statistical experience. It is also possible to estimate fatness directly, by such procedures as skin fold measurements. This measurement is done by lifting a fold of skin at a particular site of the body, and gauging with calipers the thickness of the tissues.

But such procedures are merely expedients, as the ultimate criterion of fatness is the amount of fat in the body. It is, however, manifest that direct determination of fat by chemical means cannot be done on living human beings. Fortunately, though, the composition of the human body can be closely estimated by measurements of total specific gravity, as the specific gravity of fat differs considerably from that of muscle, bone, and other body tissues. Recently techniques have been perfected for accurately measuring the specific gravity of the human being, by determining body volume through displacement during total immersion under water. Although such immersion is not a pleasant ordeal, tolerable methods have been worked out. Also inaccuracies encountered in early use of this procedure, arising from air trapped in the lungs, respiratory passages and hair, and gas in the intestinal tract, have now been eliminated by learning how to compensate for such variables.

Recent studies of the composition of the human body by this method have confirmed some earlier observations made by cruder procedures, but have also added some new and surprising findings. For example, in a broad study of body composition of young and middle-aged men, an expected trend toward increasing fatness with increasing age was clearly shown. But it was further learned that some of the overweight younger men were actually less fat than some of the underweight older men. Apparently the decreasing physical activity that usually occurs in middle life leads to a shrinkage of some muscles through disuse. Such shrinkage would cause a loss in weight were it not offset by an accumulation of fat that usually occurs simultaneously. Hence, gross body weight ceases to be a measure of fatness in these situations.

These findings do not have immediate practical application against the obesity problem. Manifestly, it is not feasible to determine fatness routinely by ducking people; weighing, skin-fold measurements and related tests must continue to serve for regular use. But the new ability to determine the fat content of the living human body accurately, together with the information on age trends and other trends in obesity now being accumulated by use of this technique, are laying a foundation of basic data with clear ultimate application to the solving of America's number one public health problem – obesity.

Ward Allan Howe

Typical of the housing found in the warm climate of the southwestern United States is this Indian adobe pueblo near Taos, N.M. Sometimes the buildings in these villages contain several stories and terraces, and agility in ascending and descending ladders would indeed be an important factor in home coming. These flat-topped houses could offer a challenge not only to a research project on climatic effects but on communal living as well.

Climate and Housing

A RESEARCH project whose purpose has been to provide for architects, engineers, and builders the means of applying to dwelling construction the accumulated knowledge about weather and its modification has been undertaken in the Institute's School of Architecture and Planning. Work under the project was divided into two parts: (1) that carried out under the direction of architects Victor and Aladar Olgyay and devoted to the development of graphical and tabular methods of presenting for the use of designers certain available climate data, and (2) that carried out under the direction of Thomas F. Malone, 2-46, Associate Professor of Meteorology, and devoted to the search for quantitative information for designers on the effects on the interior of a dwelling of measures taken to combat exterior climate conditions. The project was administered by the Albert Farwell Bemis Foundation, directed by Burnham Kelly, '41, Associate Professor of City Planning. The Housing and Home Finance Agency sponsored the climate and housing project.

First step of Victor and Aladar Olgyay was the formulation of a bioclimatic chart based on best available information regarding the effects of varying conditions of temperature and humidity on human comfort. Assuming complete reliability of this basic information, one may read from such a chart the limits of comfort and the character of corrective measures which may be required. Using the New York–New Jersey area as an example, the Olgyays then devised graphical means of summarizing regional weather conditions: when checked against the bioclimatic chart, these graphs indicate the degree to which radiation, shading from direct solar radiation, and air movement are generally required in the region and the character of measures to be taken to provide them.

Third step was the development of a simplified method for the design of devices for shading any part of the walls of a building from the direct rays of the sun. Next, tabulations in form convenient for designers were made of solar radiation data in the New York–New Jersey area. Finally, generalized observations were made on a range of qualitative tools to be used in orienting buildings for maximum comfort, and in selecting building sites for community development in the area.

Professor Malone and Don G. Friedman, '51, a research assistant in the Department of Meteorology, undertook the quantitative evaluation of the effects of solar radiation within a dwelling, using heat flow analysis as an index. This involved the study of the climatic factor of cloudiness and the determination of the extent of diffuse radiation, which proved of greater importance in over-all heat gain than had been expected. Study of a conventional dwelling showed more heat entering through windows in the form of diffuse

than in the form of direct radiation during a typical summer day. Heat flow through the roof was also shown to be of great importance.

Additional research is required before dwelling designers can balance climatic parameters, building techniques, mechanical possibilities, and human possibilities, and human requirements without preconception. Nevertheless, the research already completed shows the way to ultimate objectivity in design whether in terms of time-honored combination of movable shutters and ivy or of entirely new architectural concepts.

Low Temperature Sterilization

ALMOST since the discovery of radium itself, it has been known that destruction of microorganisms can be effected without production of heat, by emanations from radium or x-rays. Only recently, however, have extensive researches been conducted that point to the possibility of commercial utilization of the sterilizing properties of radioactive substances.

In 1950, the Atomic Energy Commission requested the Department of Food Technology at M.I.T. to ascertain the possibility of utilizing mock fission products* as sources for ionizing radiations and to compare the sterilizing efficacy of these sources with that of radiations produced by conventional particle accelerators. During the past two years studies have been conducted at M.I.T. on the use of radioactive cobalt-60 as a sterilizing agent, under the direction of Professor Bernard E. Proctor, '23, Head of the Department of Food Technology, and Samuel A. Goldblith, '40, Assistant Professor of Food Technology. The work has been supported by the Atomic Energy Commission.

The first project undertaken at M.I.T. was the design and construction of a building suitable to house sufficient cobalt-60 to produce radiation of more than 1,000 curies. The amount of energy represented by such a quantity of cobalt-60 is equivalent to more than that of all the radium in the world as of 1945. The installation of such a powerful source of radiation on the M.I.T. campus brought with it many problems, because radioactive cobalt-60 is forever emitting powerful radiations which cannot be stopped.

In co-operation with the Radiological Safety Laboratory at M.I.T., the members of which also aided in outlining a safe operating procedure for the use of the source, a building was designed that was modest in cost and offered complete safety to all operating personnel, who could remain in the building for 24-hour periods day after day without injury to themselves. Actually the building was designed to offer complete protection at all times to operating personnel from sources of cobalt-60 radiation of from 5,000 to 10,000 curies.

During the past year research has been under way with different types of spoilage organisms commonly found in food and drug products, to study their relative radio-sensitivities to the gamma rays from the cobalt-60 source. The data obtained are being compared with data previously obtained on the effects of cathode rays produced by particle accelerators. Naturally any series of comparative tests such as these is dependent, to a great extent, on the dosimetry of the various types of radiation. For this reason, great emphasis has been placed on a study leading to an accurate calibration of the kilocurie cobalt-60 source.

A new method of calibrating the source has been devised by Sol Davison, of the M.I.T. Division of Industrial Coöperation. This method uses a small calorimeter, which fits into the source and can be used for determination of the dose of radiations emitted by the isotope. The agreement between the results obtained by three different calibration techniques, one of which (the calorimeter) is physical and two of which (methylene blue and ferrous-ferric dosimeters) are chemical, has been good, which indicates that the chemical calibrations of dose made previously were correct.

With the satisfactory completion of the program of calibration, considerable study has been devoted to means of preventing such effects of radiation, as changes in flavor, color, and odor, all of which would be undesirable and deleterious to the materials being bombarded. Excellent results have been obtained on the basis of a novel idea, devised in the Food Technology Laboratories, of introducing so-called "free-radical acceptors" into the foods before irradiation.

M.I.T. Photo

Ample safety precautions are taken in handling radioactive cobalt-60 in the research program of the Department of Food Technology. The vault in which the cobalt is stored consists of a blockhouse of concrete with walls and roof one foot thick and a lead-steel door containing one inch of lead capped by two half-inch layers of steel on each side. In this door is a smaller door, near the top, for introducing samples.

* The term "mock fission product" is applied to substances that, while not disintegration components of uranium fission, are produced in nuclear reactor piles.

It is hoped that a larger source of cobalt-60 can be obtained in the coming year to permit the sterilization of greater quantities of food per unit of time and to permit higher dose rates so that studies can be made under conditions more nearly approximating those of commercial operation.

The results of the Institute's program of studying sterilization at low temperatures through the use of powerful sources of radiation have been encouraging. Although much work yet remains to be done before techniques now under study can be applied commercially there is every reason to believe, at present, that the sterilization of food products – especially those that are sensitive to high temperatures – may be effectively, quickly, and inexpensively carried out by utilizing waste products of nuclear reactors.

Food in Civil Defense

Food is a prime factor in civil defense, whether civilians be under siege or under aggressive attack, as in large scale bombings. Now the cold war has added a third kind of emergency in which food plays a key role, namely the blockade, as exemplified by the blockade of Berlin extending from June, 1948, to May, 1949. Accumulated experience in the feeding of civilians in all three of these emergency situations is now known through publication of reports given at an epochal conference on Food in Civil Defense, held at London, England, late in 1951.

Much of the knowledge in the British reports was gained during the London blitz of World War II, which gave rise to an unparalleled experience in the feeding of an immense urban population under continous, intensive enemy attack. Should large scale hostilities break out in the future, it seems more than likely that combatants on both sides might well be faced with problems even more serious and extensive than those encountered in feeding large numbers of persons, either in London during World II, or in the attempted freeze out of Berlin during the cold war.

Immediate food needs of the blitz victims were supplied from canteen trucks. It was quickly learned that prompt serving of a hot, sweet drink to the stricken people was the most helpful initial measure. Then, within a few hours of the bombing, at the latest, a hearty, hot meal was given to the victims. Refreshment thus provided proved to be a crucial factor in re-establishing the morale of the victims, and in impelling them to take affairs into their own hands in attempts to solve some of their own dilemmas.

The next problem was to provide for households that were not directly hit by bombs, but whose food supply was cut off by the attack. Although London homes stockpiled certain foods for just such emergencies, two staples – bread and milk – could not be thus stored because of their perishable nature. Therefore supplies of these two staples were rushed to each bombed area as soon as the initial exigencies of the attack had been coped with. It is noteworthy that under such conditions the consumption of bread rose to twice the usual level. Bread, the staff of life, apparently becomes all the more a staple food in times of severe stress.

After the most urgent food problems of bombed populations had been relieved, the next step was to salvage as much food as possible in local stores and warehouses that had been hit by bombs. The specific techniques and procedures, developed for such salvage, were so perfected that it was repeatedly possible to recover most of the foods in warehouses that had been hit directly and were totally demolished. Instruction of the people in safe use of the salvaged food was part and parcel of the recovery operations. For example, before eating salvaged foods packed in glass, consumers had to be taught to sterilize the contents by boiling. This precaution was needed because of the possibility that bacterial contamination might have lodged under the rim of the cap of the glass containers, as a result of the soiling involved in bombing and subsequent salvage, and the further possibility that this contamination might reach the contents when the container was opened.

Although atomic warfare was unknown in the European phases of World War II, radiological attack must now be reckoned with; hence a portion of the London conference was devoted to this subject. For example, safe limits of radioactivity of foods or beverages, exposed to an atomic blast, were announced. Food or drink that is consumed regularly over a period of 10 days may have beta-gamma activity up to 200,000 disintegrations per minute per cubic centimeter without harm to the consumer. On the other hand, if consumption continues for as long as 30 days, no more than 70,000 disintegrations per minute per cubic centimeter is safe.

Reports on the Berlin blockade of 1948–1949 showed that the main food problem then was to get a maximum of nourishment to the blockaded population with a minimum of weight, in order to reduce the demands on air transport. This aim was achieved the same way that a camper, carrying rations for an extended period, keeps down the weight of his pack; namely by transporting foods with minimal water content, and restoring, with locally available water, the moisture level necessary for palatability. Most foods, as eaten, are composed largely of water; potatoes have 80 per cent, fruits 90 per cent or more of water, and so forth. Therefore vegetables and fruits were flown to blockaded Berlin in dehydrated form. Powdered milk and eggs were similarly used. Dried meats were not used, because unpalatability militated against their acceptance, and because canned ready-to-eat meats effected a saving of cooking fuel that, like the food, had to be flown in. The dietary supplied to blockaded Berlin was rounded out with ingredients naturally low in moisture, such as sugar and fats which are wholly free of water, and dried beans, flour and cereals, all of which contain about 10 per cent moisture.

Bringing in flour by airplane also necessitated flying in fuel with which to bake it into bread. Baked bread or crackers would have weighed less than flour plus fuel; but ample freshly baked bread (again the staff of life) was found essential to civilian morale.

These are the high lights of the London Conference on Food in Civil Defense. All of us hope that this carefully recorded and skillfully analyzed experience need never be used, whether in attacks of a shooting war or under a cold-war blockade. Nevertheless it is reassuring to know that the knowledge is available should need arise.

Following a Cold Trail

To Discover Plant Relationships, Botanists Work over Old Clues and Uncover a Great Deal of Research by Many Workers

By ERNEST C. CROCKER

THE new miracle weed killers live pretty well up to the claim made for them of killing weeds without killing the grass. Weeds, in this sense, are plants growing where not wanted. Killing usually is accomplished in a few days by overstimulation, using only a few milligrams of chemical per plant. A few kinds of weeds or plants having deep roots, such as clover, may lose only the tops and upper roots, allowing the deeper roots to re-establish the plants. What is there about grass that makes it immune to this selective labor-saving chemical that is not characteristic of most weeds? Actually, it appears that "2,4-D" (2,4 dichloro phenoxyacetic acid) and its even more active relative "2,4,5-T" (2,4,5 trichlorophenoxyacetic acid) stimulate grass violently, as they do other plants, but grass is able to hold its metabolic forces in sufficiently good balance to remain alive. Grass, with its narrow leaves, is superficially very easy to distinguish from most other plants. But is grass related to other plants in any way or is it a separate creation? Are all plants closely related?

The attempt to answer these questions has led to the uncovering of a great deal of research by many workers, which combined with natural history, geography, chemistry, and biology makes an interesting piece of scientific detective work. Let us review the subject without the handicap of the forbidding jargons of the specialists. It leads to an answer, much incidental information, and a wealth of entertaining speculation.

Rutherford Platt

Fig. 1. Canada lily, a typical flower, showing plainly the stamens and pistil of each blossom.

Botanical History

All people are curious at times, but curiosity with some is all-important, driving them to be investigators. Ever since classical times, a few people have investigated plants and their relationships.[*] Theophrastus, a Greek philosopher of 2300 years ago, concentrated on plant description to such an extent that he became known as the "Father of Botany." He described only about 480 species, it is true, but did so with such minute detail that we have no difficulty today in telling which plants he meant. He would start with the roots and work up stem and branches through the leaves and flowers to the fruit. He concluded that the habit of growth was the most fundamental characteristic, and classified the plants as trees, shrubs, undershrubs, or herbs. He also observed the foliage throughout the year, noting whether the plants were evergreen or deciduous; and whether they were annuals, biennials, or perennials. Perhaps he had in mind the specification of valuable medicinal plants, so that no mistakes need be made through careless identification, but more likely he worked on this project as a purely intellectual exercise.

Herbalists there always have been, in all lands. Through the centuries they collected much lore and a great deal of accurate description of plants. Linnaeus, writing in the 1730's, quoted upwards of 1,000 references in his great catalogue *Genera Plantarum*. At that time, some thousands of species of well-known plants had been described, although not on the basis of any logical system. Each grouping depended upon the worker's own thinking. There was continuing advancement, but sometimes a wrong theory led to regression for a time, until finally it was discarded. Some workers made accurate observations and analyzed their findings, while other equally accurate observers followed the method of Aristotle and reasoned, not always on accurate grounds, to arrive at their conclusions. Thus, the Italian, Cesalpino, reasoned that leaves were for the protection of buds, flowers and fruits. Actually, leaves are an important

[*] Please see numbered references at end of article, page 230.

plant organ – virtually lungs. He denied that there was sex in plants. Tournefort, a strong personality who dominated botanical thinking in the Seventeenth Century, followed Theophrastus in dividing the plant kingdom according to the habit of growth, as of trees, shrubs, and herbs, but he used the flower as an aid in grouping and describing the species. He worked only with the corolla of the flower, noting the number of petals and whether or not they were connected or separate. He disdained to consider stamens and pistils, thinking them mere decorative appendages, without real function.

About 1700, the Frenchman, Sébastien Vaillant, dared to attack the ideas of the great Tournefort, but was despised for his pains. Vaillant wrote a tract pointing out that stamens and pistils were really all that mattered in a flower, that these were the sex elements of the plant and had to be reckoned with. As a young man of 23, Linnaeus was much impressed by Vaillant's thesis, and seems to have accepted it in principle.[9] Later Linnaeus went on to develop a sexual system for the classification of plants, using only stamens and pistils for making the groupings. He specified some 24 classes, based first on the male element, the stamens, and second on the female, the pistils, as illustrated in Figure 1. Thus, his "Diandric Monogynia" class had two stamens and one pistil; "Pentandric Pentagynia" had five of each, and so on. This type of grouping placed many closely related species of plants together, but without directive indications as to which might have descended from which. The classification of Linnaeus was strictly an artificial census of plants based on sex elements alone. It was remarkably definite and easy to use, however, and furnished a desirable key to a vast group of plants. With it, Linnaeus astounded many of the scientists of the time with his grasp of world-wide plant relationship.

While the great naturalist Linnaeus sold the world on the existence of sex in plants and of its importance in classification, there gradually developed a desire to incorporate all that was known about plants, including sex, into a "Natural System." This term "natural" meant different things to different workers, according to what was natural to each of them, but the principle of using multiple determinants has proved to be entirely sound and practical. Some workers visualized separate creation for each species, whereas others had a picture of a continuing trend of evolution from many or few varieties or even from one original kind of plant. Evolution had been in the minds of certain thinkers from the time of the great Greek philosophers, but it became entrenched and accepted only after the publication of Darwin's great work in 1859. His book *On the Origin of Species by Means of Natural Selection*, or, *On the Preservation of Favored Races in the Struggle for Life* proposed a working mechanism to account for evolution, and the book had an astounding effect. Thereafter, nearly all plant classification systems, particularly of the flowering plants, included the thought of evolution, and arranged plants in the order of development as well as it could be determined. Thus, all monocots,† including grass, were found to fit together into one great phylum or sequence, and the dicots into another, of two parts: (1) the more primitive dicots with separate petals; and (2) the higher-developed dicots which had flowers with connected petals, often in tubular or irregular form. This arrangement was natural and apparently

† Monocots are plants which start with one cotyledon (first leaf or seed leaf), and dicots start with two. These seed leaves furnish nutrition to the plant until it establishes feeding through its own roots and green parts. A well-known dicot is the bean, whose two seed leaves are shaped like half beans. Monocots, such as corn, usually leave their one cotyledon in the ground with the plant rising above ground as a spear; dicots usually carry their first leaves up on the stem.

Chicago Natural History Museum

Fig. 2. Welwitschia, a strange "tree," which grows only in two deserts of southwest Africa. The ribbonlike leaves extrude continuously outwards and become worn away at the ends through lashings by the wind. Note the conelike fruiting bodies. Taproots, often 75 feet long, reach down to water.

accurate in general, but there still existed missing links that should connect the various phyla, to make the grand plan of evolution more evident. Particularly, the seed plants needed to be anchored to some earlier type of plant.

Botany today is a pragmatic science, turning to its use all kinds of evidence. It evaluates the form of the various plant parts (morphology), including wood fibers and pollen; chemical and physical evidences of relationship; paleobotany – the science that studies relics of plant development as shown by fossils, genetics; various experimental techniques; and geographical distribution. While there still remain missing links, the relationship of some formerly isolated groups, such as the cacti, casuarina, the proteaceae and other highly specialized plants have by now been resolved satisfactorily.

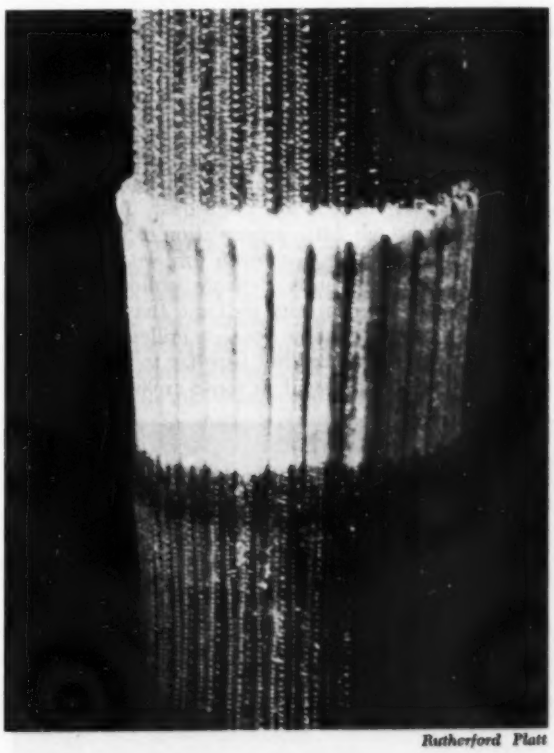
Modern Investigations

There are numerous chemical substances that exist throughout, and indicate certain species or even larger groups of plants. Some of these substances can be shown by laboratory tests and some can be shown by their attraction of certain animals, in nature. Through odor, potato bugs find individual potato plants a mile from any other plants of the type; these insects will even settle on wild relatives of the potato family if no potato plants are to be found. The cabbage butterfly lays its eggs on various members of the mustard family, such as turnips, radishes, and the wild mustards, nearly all of which have strong pungent odors. It is occasionally fooled by the totally unrelated nasturtium, which even to us has a similar sharp odor.

Laboratory tests of the lignins of woody fibers differentiate between the woods of the seed plants and those of the gymnosperms, which include the conifers, ginkgoes, and the cycads. The Mäule test, which has been investigated intensively by the author, gives bright red colorations with the woody fibers of seed plants, tree or herb, whether these be monocots or dicots, and only pale brown with most other woody fibers.[6,7] A strange group of only three species, the Gnetaceae, (Gnetum, Welwitschia, and Ephedra) which have much in common with the conifers, gives bright red colors by this test. The ribbon-like leaves of Welwitschia may be seen in Figure 2. This anomalous group rates as considerably advanced over the conifers for it has vessels in the wood and other evidences of high development including broad leaves.[2] The placement of the Gnetaceae in the evolutionary scheme is still tentative, but on the basis of morphology, and the Mäule test, as well as serological reactions, they could be decendants of the Podocarpus group of the conifers. Conveniently, a certain species of Podocarpus (amara) gives positive Mäule tests, indicating a species within which the great evolutionary jump might have occurred. Chemical tests can undoubtedly be developed for finding bridges over other doubtful passages, but will call for much work. Thomas P. Hilditch has shown that the compositions of the fats of seeds tend to follow botanical patterns, although four fatty acids occur in nearly all fats. Alkaloids abound only in certain plant groups, sometimes extending over many species.

Mez and his co-workers surveyed all manner of plants by serological reactions and obtained a most impressive family tree of the vegetable kingdom.[11] In one sense, this was a chemical method of attack, for it depended on chemical variations in the proteins of the particular species. Assumptions are tacit that protein compositions change gradually and continously as the plants evolve, that the same patterns of change did not occur in different branches of the plant kingdom, and that in any species once established there was no further chemical change with time. Serodiagnosis is a powerful tool and is well adapted for the survey of botanical progress on a big scale, especially at this late date. It makes great appeal to the imagination. In operation, a rabbit is sensitized to a particular plant protein injected into its blood. Drawn blood acquires the property of precipitating when treated in a test tube with solutions of proteins closely related to the one used for sensitization. There are degrees of precipitation and turbidity which can be used to show several stages of closeness of relationship between the plants furnishing the proteins. With such a device orphan groups of plants can be shown to have slight or strong connections with their next of kin. When Mez's remarkable family tree has been further verified by other workers, it should become established as an indicator of great value.

A rather specific physical test for relationships within the Euphorbiaceae has been developed using electrophoresis.[12] It shows the degree of positiveness



Rutherford Platt

Fig. 3. Magnification of stem of a living descendant of a coal-age plant, a "horsetail" (Equisetum hyemale). Note reflections of silica, a chemical constituent of this plant. There is so much silica in these stems that they often are used as scouring reeds.

Chicago Natural History Museum

Fig. 4. Photograph of a diorama showing how coal-age vegetation might have looked. Trees of those times did not have bark, as we know it today.

of the charge on particles of the latex of each species of this group. The findings check well with the series of species which the morphologists have agreed upon.

Paleobotany is the study of plants of the past as shown by fossil remains.[14] If samples of a large part of the vegetable kingdom of the past had been preserved in the rocks, it would be necessary only to find the remains and read off the sequences. Actually, fossilization was only an occasional accident and the records of past vegetations are notoriously incomplete. There was relatively little preservation of herbaceous plants or their parts, or even of woody stems. Strangely, the apparently delicate pollen of many plants has kept its form very well and that frequently is all that remains of some species. Pollens are waxy and do not decay rapidly but fossilize to make up an important part of the coal in some areas. While ancient records are very spotty and hard to interpret, they tell us of the existence in the coal measures of plants which are extinct today, such as Calamites, Sphenophyllum, and Sigillaria, and of a few forms, including the horsetails and clubmosses, which have survived to this day in reduced or modified form, as may be seen in Figures 3 and 4. Coal plants existed some 300-400 million years ago, conifers and ferns of various kinds began to be conspicuous 200 million years ago, while the modern types of seed plants appeared "suddenly" about 100 million years ago, in the Cretaceous era, about the time that the first of the mammals appeared. This suddenness probably was more apparent than real.[13] The earliest specimens often show whole groups of trees including willows, oaks, plane trees, and poplars, not much different from those that exist today. There is particularly poor record of the evolution of flowers, but the probability is that insect and flower evolved together.[4] Figure 5 pictures a bee operating the cross-pollinating gears of a flower. The first bee-fertilized flowers, as well as the first bees, go back as much as 40 million years. Bees of that era are occasionally found well preserved in amber. Pollen findings show the kinds of plants growing in the long ago, both locally and generally, but only indirectly indicate plant relationship. Even though workers are few, lucky finds are still being made to help fill out and clarify the fossil record.

Rutherford Platt

Fig. 5. Bee, operating the cross-pollinating gears of a Lobelia syphilitica flower.

Darwin's concept of the mechanism of evolution – that plants vary enough to develop gradually into different species and maintain the new forms – is now known to be incomplete. Hugo De Vries, the Dutch botanist, showed that a plant may reproduce itself uniformly from generation to generation for a long

(*Continued on page 226*)

Science Publicity
—CHALLENGE AND DILEMMA

As Scientific and Public Affairs Grow Closer, Our Citizens Need a New, Sounder, and Better Understanding of How Science Really Operates

By JOHN I. MATTILL

One of the classic M.I.T. stories about science reporters is that of the girl who, after hearing a technical paper on new dielectrics for high-capacity condensers, asked the scientist for some more understandable concepts. She was told that the new material might resemble the ceramic used on bathtubs, and that, in its ultimate development, a large condenser might store enough energy to operate a motor car. The resulting news account, to the embarrassment of all concerned, suggested that bathtubs might replace the entire engine in the motor car of the future.

Science reporting today is, in general, far better than this example indicates. Indeed, newspapers, in the past 20 years, have made spectacular progress toward publishing interesting and informative reports of new scientific developments. The pioneers – among them, Watson Davis of Science Service, Waldemar Kaempffert of the New York *Times*, David Dietz of the Scripps-Howard papers, John J. O'Neill of the New York *Herald Tribune*, the late Howard W. Blakeslee of the Associated Press – have now been joined by many others who take pride in making information about science available and understandable to the nonscientist citizen. The National Association of Science Writers, originally fostered by the American Association for the Advancement of Science, now has nearly 100 active members, and science writing is recognized as a very specialized branch of journalism.

Science reaches its largest audience through the mass communication mediums – newspapers, popular magazines, radio, and television. In most of these mediums, information about science has the context of news. It competes for public attention with other news, such as the cold war, the weather, crime, and national politics. To meet this challenge, and so to assure that their work is read, heard, or seen, science writers have developed a number of very effective techniques of popularization.

Scientists often look on some of the tactics of popularization with doubt, but the journalist's reply is that even though the scientist has, in fact, some justice on his side, the disadvantages of popularization must be accepted in the paramount interest of conveying science to its largest audience. And the journalist can point to some impressive results: certainly science writing during the years since the founding of Science Service (an event which, in many ways, marks the beginning of wide newspaper interest in science) has helped make the public conscious of science as a force in our daily lives. Writers can take much credit for the increasing public interest in, and support for, science on the basis of its contributions toward a higher standard of living for us all. Whatever follows is not intended to belittle these continuing achievements: it remains up to the scientists, working with these writers, to see that science continues to receive due notice in press and radio. But it is increasingly important that the aims and methods of science, as well as its accomplishments, be made understandable to the public.

During the years since World War II, science writers have been working in a new kind of environment, wherein the interrelation of national scientific and nonscientific affairs has become increasingly clear. What scientists can accomplish in the next five years is now, very obviously, dependent on decisions in the nonscientific realms of politics, law, and international relations. Conversely, international and domestic policies five years hence will depend, at least in some measure, on what scientists are able to do in the intervening years.

If these interrelationships are to be exploited constructively, scientists and the public need to get closer together and to understand each other better. A revaluation of science's public relations is in order: perhaps the simple matter of "selling" scientific effort on the basis of its contributions to our health and comfort has passed its greatest usefulness. Does the information about science, which reaches nonscientists today, fill the larger need of a public whose decisions will help mold the future course of science? Are we helping to create what Edward C. Fuller of Champlain College calls "the needed middle class in science"?

The thesis of James B. Conant's interesting volume, *Science and Common Sense*, is that, in general, purely factual information about the results of scientific inquiries is inadequate to meet the public's need. He writes:

> In my experience, a man who has been a successful investigator in any field of experimental science approaches a problem in pure or applied science, even in an area in which he is quite ignorant, with a special point of view . . . which is independent of a knowledge of the scientific facts or techniques in the new area to which he comes. Even a highly educated and intelligent citizen without research experience will almost always fail to grasp the essentials in a discussion which takes place among scientists concerned with a projected inquiry. This will be so not because of the layman's lack of scientific knowledge or his failure to comprehend the technical jargon of the scientist; it will be to a large degree because of his fundamental ignorance of what science can or cannot accomplish.[1]*

In a sense, this is a dynamic view of science which adds an entirely new dimension to the factual information commonly possessed by even the most informed nonscientists today. It is probably what I. Bernard Cohen meant when he wrote: "Each of us has a new burden of citizenship not shared by previous generations: a new responsibility that calls for a secure understanding of the scope, nature, and effect of scientific enterprise."[2] All citizens, Dr. Cohen declares, have become "lay administrators of science," and hence all need to be acquainted with some of the principles of scientific development, the conditions under which discoveries are made, and how practical applications of these things come to pass; in short, the "tactics and strategy of science."

This, too, is what the Executive Committee of the American Association for the Advancement of Science must have had in mind during its meeting at Arden House in 1951, when it recommended that the Association "not only recognize but attack the broader external problem of the relation of science to society. . . . It is absolutely essential that science – the results of science, the nature and importance of basic research, the methods of science, the spirit of science – be better understood by government officials, by businessmen, and indeed by all the people."

The science information in mass mediums today deals principally with *results*. By and large, scientists get in the news when they have found out something very specific, done something new (and preferably, very surprising), or built a shiny gadget which is different, larger, or more ingenious than previous machines. In most scientific work these chances come seldom; when they do come, such events are indeed worthy of suitable commemoration. But a highway is more than a row of milestones, and science is far more than a series of new gadgets which, perhaps, later make possible some conclusive results.

In itself, this suggests that most modern science writing for the large audiences does not get very close to picturing in full the tactics and strategy of science. Does it, in fact, depart so far as to result in actual misconceptions about scientists and their work?

Newsmen insist that their science material must have a "news peg," to make sure that what is written about science can compete with other news events and so to justify interest in it. In one sense, this is fair enough, since most scientific developments are indeed announced to the scientific world at professional meetings or in technical papers. The nonscientific world gets its news from writers who attend the same meetings, or read the same reports. But it is not easy for the layman to avoid the impression that results come in laboratories as dramatically and suddenly as they reach the public. Scientific discoveries are, in fact, not discoveries at all in a sense of sudden revelation; they are developments, gradually realized over months or years. If science gets its public support only on the basis of its dramatic discoveries, the spectrum of its activity will soon become warped and the result ineffective.

The way to make a report on science interesting to laymen, the journalist will tell you, is to make it seem practical for solving the layman's personal or business problem. This is a formula which works wonders: it is very easy to "sell" a report about a new kind of automobile engine, much harder to make a meaningful account about a new kind of condenser dielectric, and very difficult indeed to write about the abstract theory of conductivity. So the story goes out that the dielectric may make possible a bathtub to substitute for the engine in your motor car. But the scientist who studied the condenser dielectric had no more idea of putting it under an automobile hood than he had of sending it to Mars. Probably he was not at all concerned with the possibility of practical applications; that question simply had not entered his mind. In these pages there is no possibility of defining the various motives of various scientists. Suffice it to say that they are not those which popular accounts of scientific developments might often suggest to the nonscientist reader.

* Please see numbered references at end of article, page 224.

Nor is it here possible to study the various criteria by which is measured the success of scientific projects. It is enough to say that practical application of the results is only one criterion of many, and one which applies only slightly, if at all, to most researches in colleges and universities, even in engineering fields. Since activities which have reasonably obvious applications are emphasized in mass mediums, even avid followers of science in these mediums know only a small segment of the total panorama of scientific activity.

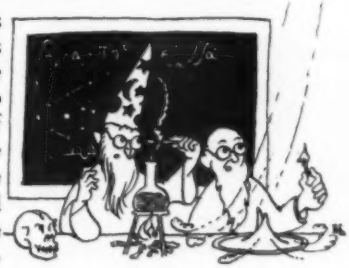
The practical results achieved in laboratories during World War II have helped to make scientific enterprise a national concern. These successes came during a period when rigorous planning and organization were enforced upon science as upon many other elements of national life. Under that regime science—more accurately, engineering—produced an unparalleled array of brilliant new devices; to the layman who measures success in terms of practical results, World War II marked a sort of scientific renaissance. Taking little cognizance that it is the purpose of science to understand nature, whereas it is the aim of engineering to apply knowledge gained by science, the layman may well ask: "If science came into flower brilliantly then, why do scientists now seek so vigorously to escape from all forms of planning and organization?"

It is true that the practical results, which make most appeal in the layman's reading about science, are often subject to planning, as they were during World War II. It is not so easy to make a case, in mass mediums, for the equally vital unplanned exploration of new horizons. For there can be no master minds to plan this kind of fundamental science in advance; no one can predict where new directions will lead.

The potential of the lay administrator of science is nowhere clearer than in the matter of so-called basic research, that is, studies stimulated simply by curiosity, with no immediate practical ends in view. Since World War II, scientists have been struggling first for creation, and now for adequate support, of a National Science Foundation dedicated principally to the encouragement of basic research and scientific education. The fight has not been easy, and is not yet won. The arguments before the Appropriations Committees of Congress have served to demonstrate how little is known about the role of basic research in the larger pattern of scientific development. At the 1952 hearings before the House Appropriations Committee, Representative John Phillips of California finally concluded that basic research was "a sort of a type of fishing expedition." On an earlier occasion, funds were denied when the House Committee concluded that the United States cannot afford the luxury of "unproductive" fundamental research at a time when practical needs are so emphasized by the international situation.

To a science writer, the baffling thing about basic science is that it defies most of the attention-getting methods which he is accustomed to using. Nor is the fact that basic science is the necessary foundation for applied science easy to prove in simple terms. Choose any specific example and the relationship is likely to be remote — so remote that it seems to a nonscientist reader like trying for the fifth card of a royal flush. The application of any basic study, if indeed one turns up, is thoroughly unpredictable; and this confuses the popular conception that science is most methodic and orderly in its progress. To a science writer the puzzle is simply how to convey, to nonscientists, the true role of what is called basic research in the larger pattern of scientific affairs. To a large extent it remains unsolved.

It is easy for a popular writer to picture a bearded scientist at work over his smoking test tubes and retorts, a model rocket screaming with an ear-splitting wail, or a blackboard full of the most complex calculations about an imaginary point in an imaginary vacuum. This kind of picturesque language helps make things readable; complexity made understandable flatters the reader. Hence the temptation for a writer to make scientific subjects vastly more complicated and inaccessible than they are in fact. Instead of attracting a real understanding of science, there is at least the possibility that this kind of approach may scare an audience away from even superficial information. After a survey made with the help of the firm of Hill and Knowlton, the Manufacturing Chemists' Association has been told that there are "overtones of black magic in the public's impression of the chemical industry," and Hill and Knowlton add that "what people do not understand they are inclined to fear."



Professor Eric M. Rogers of Princeton University is among many who have warned of the tendency to "glorify the 'wonders of science,' paint the romance in glowing colors, and make the scientist seem a wizard who dispenses knowledge and explanations."[9] The recent *Saturday Evening Post* (October 20, 1951) account of M.I.T. states: "Buck Rogers Would Love It Here: Ordinary mortals are uncomfortable at Massachusetts Institute of Technology." A career in scienee may be demanding of some special talents, but these are not uncommon ones, and not all successful scientists are supermen, geniuses, or absent-minded professors. If the decline of students entering science in high schools and colleges is to be reversed, this Buck Rogers theory needs a vigorous attack. Scientists are citizens and humans, just like everybody else.

The effort toward picturesque language may raise another difficulty to a real understanding of scientific enterprise. It is easy to attract attention by saying that your desk is not really made of what you see. Rather it is composed of molecules floating about in space, and the molecules in turn are made up of atoms whose electrons, neutrons, and protons are also rushing about in their own private universes. The lay reader, sitting on a solid chair at his hard desktop, may find this intriguing but a little hard to take. In their place the concepts of molecules and atoms are most useful, but the scientist would find

the application of elementary particles to office furniture no more satisfying than the layman does. Misapplication of concepts of science actually confuses the role, and so minimizes the value of this kind of conceptual scheme.

If you ask an intelligent nonscientist how to account for the progress and success of scientific enterprise during the last 50 years, he would probably start talking about scientific method. The question is still open to argument, but many of his colleagues are now coming to agree with the view of Percy W. Bridgman, physicist and philosopher at Harvard University, that there is no such thing as the scientific method, but that the progress of science results simply from doing "one's damnedest with one's mind, no holds barred." Or, as Dr. Conant expresses it from a historian's point of view: "The stumbling way in which even the best of the scientists in every generation have had to fight through thickets of erroneous observations, misleading generalizations, inadequate formulations, and unconscious prejudice is . . . largely neglected by those expounders of the alleged scientific method who are fascinated by the logical rather than the psychological aspects of experimental investigations."[4] Professor Rogers asks: "Are scientists themselves better for their studies [with scientific method]: tidy and systematic in their general life, critical and unbiased in their general thinking?"

All this does not mean to deny that a good experimenter *tries* to base his conclusions on observed facts and to make his theories fit those conclusions. The point is that a scientist's work, like that of anyone else, depends on factors of personality and environment, and that all scientific research involves the human element of those who do it.

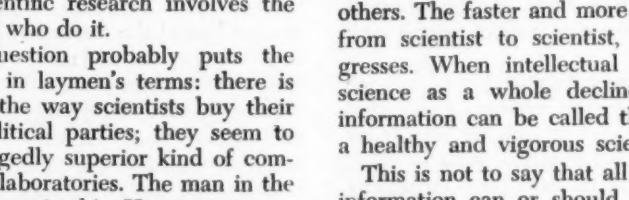
Professor Rogers' question probably puts the matter most effectively in laymen's terms: there is nothing magical about the way scientists buy their automobiles or join political parties; they seem to revert to their own allegedly superior kind of common sense only in their laboratories. The man in the street must find little sense in this. How many nonscientists have been discouraged, by such lines of thought, from a real understanding of how science works, or have been led to the confusions recorded by Anthony Standen in *Science Is A Sacred Cow*?[5]

If science can be removed from the concept of an absolute scientific method, it may suddenly become a vastly more common and understandable human activity. Leonard K. Nash of Harvard emphasizes the problem: "It is important to dispel the notion that the operations and conclusions of science have perfect certainty, that science is a miracle worker to which all things are possible. . . . Indeed, it needs to be seen as one of many human enterprises, subject to all the risks and chances that make life at once exciting and terrible, and having much in common with any other undertaking to which we bring our hopes and fears, our humility and our ambitions."[6]

The loyalty, security, and secrecy restrictions under which many scientists now labor combine to form a most serious challenge to modern science – perhaps the most serious of those challenges whose solutions must lie in the immediate political environment. Restrictions on the freedom of scientists have assumed large proportions since World War II: many scientific developments of all types and from all sources now rate the secret stamp, and scientists may be screened for loyalty before they can go to work, or even to school. Physics especially has been the victim to such an extent that Dr. Conant, speaking at Columbia University early in 1952, declared: "The general public might just as well stop reading anything in the papers about atomic energy or atomic bombs. By the nature of the case it is almost certain to be misleading. . . . Those who are competent to discuss such matters cannot do so. . . . The world being what it is today and is likely to be for a long time to come, secrecy and applied nuclear physics are words that must be joined together. But it is of the utmost importance that the general public understand the consequences of this union."

It is not easy to dramatize, for a nonscientist, the dependence of scientific progress on freedom of scientists to exchange ideas. In his first annual report as Director of the National Science Foundation, Alan T. Waterman put the matter this way: "Scientific progress is cumulative. One individual builds on the findings of other individuals or groups; his work in turn becomes modified and augmented by still others. The faster and more fully information passes from scientist to scientist, the faster science progresses. When intellectual exchange is hampered, science as a whole declines. Ready exchange of information can be called the circulatory system of a healthy and vigorous scientific body."

This is not to say that all restrictions on scientific information can or should be removed today. But those who are responsible for the decisions restricting scientists (ultimately the new lay administrators of science) need to know that there are at least two sides to the issue. As Walter Gellhorn remarks in his excellent volume on *Security, Loyalty, and Science:* "It is arguable that the United States is purchasing security at the price of progress. A secrecy program is marked mainly by apprehensive and backward glances over one's shoulder, and this may . . . retard the forward drive of scientific energies into as yet unexplored areas."[7] There is also plenty of evidence to suggest, as Dr. Gellhorn says: "The impossibility of permanently 'keeping a scientific secret' or of precluding others from independently duplicating the most closely guarded researches."[8]



(*Continued on p. 220*)

At the right is primitive equipment for washing alluvial gold ores as illustrated in a translation of Ercker's Treatise on Ores and Assaying. *At A, the washer is working the screen, and below him, at D, is an attendant at the blanket sluice. The worker who carts the ore onto the upper platform and empties it through a hole onto the screen is shown at E.*

Gold

IN FACT, FICTION, AND FINANCE

By CARLE R. HAYWARD

"And the Lord God planted a garden eastward in Eden; and there he put the man whom he had formed . . . And a river went out of Eden to water the garden; and from thence it was parted, and became into four heads. The name of the first is Pison [Pishon]: that is it which compasseth the whole land of Havilah, where there is gold; and the gold of that land is good . . ."[1]

It is evident from the above quotation that the writer of Genesis was not only familiar with gold but recognized that natural gold varied in quality. He also implies, probably correctly, that it was available for use at the very beginning of the era of Homo sapiens. Certainly man developed methods for refining gold at a very early date. The book of Job [Revised Standard Version, 1952] states: "Surely there is a mine for silver, and a place for gold which they refine."[2]

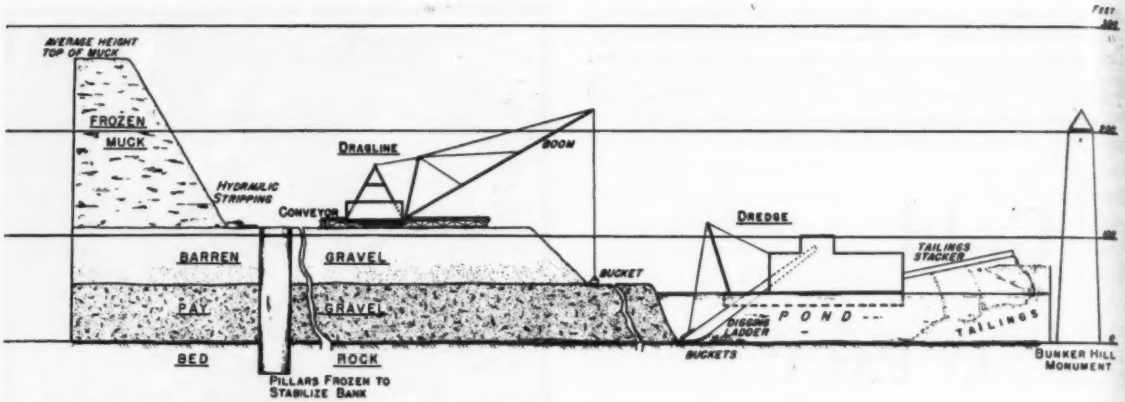
Archeologists and metallurgists agree that gold was probably the first of the metals to be put to human use, for the two outstanding properties of gold are its resistance to corrosion and its malleability. The first was the cause of its early discovery, and the two together have directed its use throughout the ages.

Primitive races have always had an eye for anything which is bright and shining, and attendance at any modern social function gives abundant evidence that civilization does not eradicate this characteristic. Even fish, animals, and birds are attracted by anything which glitters, and it is easy to visualize the ancestors of modern men being intrigued by the shiny particles they found amid the sands of certain stream beds. The name "gold," which varies only slightly in different languages, was probably derived from the Sanskrit verb "*jval*" meaning "to shine." It is highly probable that prehistoric man believed that this shiny and unusual material was of supernatural origin and its early use for religious purposes may have been due to this fact. At some later period it was found that this strange yellow substance could be easily flattened out by pounding and could even be coalesced by such treatment. Its extreme malleability made it possible to utilize gold for ornamental purposes much more extensively than would otherwise have been possible.

Archeologists have discovered gold articles of the most exquisite workmanship whose origins have been placed at earlier than 3000 B.C. and some possibly as early as 4000 B.C. These articles were in part for personal adornment, some for religious purposes and some for other uses. In many cases the discoveries have been made in royal tombs, and although modern archeologists treat such discoveries with respect and preserve them carefully, it is unfortunately true that robbers through all ages have enriched themselves by plundering royal tombs and doubtless melting priceless relics into bullion. The discovery of the tomb of King Tut-Ankh-Amen in Egypt in 1922 caused a sensation at the time and will be remembered by many readers of this article. Here was a king of minor importance whose burial place had, by chance, been untouched. His coffin was covered with about 600 pounds of gold and various beautiful gold objects

[1] Genesis 2:8, 10–12.

[2] Job 28:1.



U.S. Smelting Refining and Mining Company

As shown in this diagram of gold recovery operations at Fairbanks, Alaska, in winter a line of pillars is artificially frozen in the wet gravel to prevent caving during excavation in the summer. The pillars are spaced 40 feet on centers, and each is about 28 feet in diameter and 140 feet deep. The barren surface gravel is removed by dragline and discarded. The auriferous gravel is removed by a floating dredge carrying equipment for catching the gold.

were nearby. If all this splendor were buried with a minor king, what must have been originally in the tombs of the really great pharaohs of that period — tombs long since rifled of their contents by unknown marauders?

A quotation from Exodus indicates that, at the time of Moses, gold was used both in the cast and beaten form and the casual way in which the directions are given indicates that there was nothing unusual in the operation. "And Bezaleel [Bezalel] made the ark of shittim wood . . . And he overlaid it with pure gold within and without, and made a crown [molding] of gold to it round about. And he cast for it four rings of gold . . . even two rings upon the one side of it, and two rings upon the other side of it. And he made staves of shittim wood, and overlaid them with gold. And he put the staves into the rings by the sides of the ark, to bear the ark."[3]

The golden calf made by Aaron was produced by melting the jewelry of the Israelites and casting it into an idol for worship.

We are not sure why ancient kings and emperors were buried with their riches. We do know, however, that when their tombs were robbed there was probably little loss of life, whereas the treasure may have originally been in large part collected by means of bloody wars in which entire populations were killed or enslaved.

The gold taken from the earth since the beginning, being nearly indestructible, has gone through a succession of dramatic cycles. It has been collected and hoarded, fabricated in various ways, and used for many purposes. Its possession has however been an invitation to plunder and murder, and history is full of tragic events which have been brought about by efforts to seize it. A terrible price in blood and suffering and much wealth was surely paid for every ounce of gold accumulated by mankind up to the last half of the Nineteenth Century. In spite of this fact, gold has held its lure throughout all history and probably far back in prehistoric time.

Any reader of the Old Testament stories can note case after case in which robbery and tribute were the real purpose of war, and all history is filled with similar accounts.

There is a story in the Old Testament which illustrates how the predatory nations operated some 2,500 years ago and perhaps in very recent times. King Hezekiah of Jodah had been seriously ill and the king of Babylon had sent messengers with a present and a letter of sympathy. "And Hezekiah was glad of them, and shewed them the house of his precious things . . . there was nothing in his house nor in all his dominion that Hezekiah shewed them not. Then came Isaiah the prophet unto king Hezekiah, and said unto him, What said these men? and from whence came they unto thee? And Hezekiah said, They are come from a far country unto me, even from Babylon. Then said he, What have they seen in thine house? And Hezekiah answered . . . there is nothing among my treasures that I have not shewed them. Then said Isaiah . . . Behold, the days come, that all that is in thy house, and that which thy fathers have laid up in store until this day, shall be carried to Babylon: nothing shall be left . . ."[4]

The Punic Wars were primarily a struggle for the gold of Spain. Caesar's invasion of Gaul was carried on to secure gold. The Spanish conquests of Mexico and Peru were for gold and silver, and innumerable other instances might be cited. We have detailed accounts of the methods used by Cortez and Pizarro and their needless slaughter and enslavement of the

[3] Exodus 37:1–5.

At one of the U. S. Smelting and Refining Company properties in Alaska, barren surface material is removed with high-pressure water jets, or hydraulic giants.

[4] Isaiah 39:2–6.

Black Hills Studios, Inc.

Left: *Aerial view of the largest gold operation in the United States – Homestake Mining Company in Lead, S.D.* Below: *Gold dredge and thawing equipment at one of the U.S. Smelting Refining and Mining Company properties in Alaska. Sometimes in Alaska the auriferous gravels are perpetually frozen down to bedrock and require thawing. After a large area has been thawed, which may take several seasons, the gravel is excavated by a floating dredge and passed over screens and riffles to recover the particles of gold. Occasionally, bodies of ancient mammoths, well-preserved, have been found in the frozen ground.*

people of Mexico and Peru, and it is probable that some of the more ancient invasions of numerous other countries were just as barbarous.

Pliny who was well informed on the history of his time, and perhaps was not so easily shocked by bloodshed and cruelty as we might be today, is quoted as follows: "Oh! that the use of gold were clean gone! Would it could be quite abolished among men setting them, as it doth, into such cursed and excessive thirst after it."

Goldbeating

The general attitude toward gold in the Middle Ages is shown in a *Treatise on Ores and Assaying*[5] written by Lazarus Ercker in 1580, translated by Anneliese G. Sisco and Cyril S. Smith, '26. "Gold is considered to be the very best, the most exalted, the most important, the most beautiful and the most noble of metals, just as the sun is the brightest, the most beautiful, and the most splendid light among the planets and stars. Just as the sun by its innate celestial power and heat quickens and wakens and stirs into life all things on earth – so is gold the most effective and the most curative of metals, a true cordial and preservative in case of all kinds of poisonous and dangerous maladies, a metal which never loses its splendor, radiance and brilliance in either fire or water or soil and which cannot be destroyed or ravaged by any impurity; which withstands assaying, cementation, hammering, punching and rubbing and is not lessened thereby."

This account serves to remind us that the art of gold-beating, whose origins are lost in antiquity, has changed little over a period of several centuries. Gold leaf is about 1/300,000 of an inch thick. Although procedures for producing it vary in detail, the operations are somewhat as given in the following outline which is abstracted from the 14th edition, *Encyclopaedia Britannica.*

1. Melt the gold, alloy it to the desired amount, cast it in bars and roll it into a ribbon such that a piece 10 feet long and 1½ inches wide will weigh an ounce.
2. Anneal the rolled product to make it soft and ductile and cut into short lengths.
3. Place pieces between the leaves of a "cutch" which is about ½ inch thick and 3½ inches square containing 180 leaves of tough paper, vellum preferred. Beat for 20 minutes with a 17-pound hammer.
4. Remove the sheets of gold, cut each into four pieces and put between the skins of a "shoder" which is about 4½ inches square and contains 720 second-grade skins. Beat two hours with a nine-pound hammer.
5. Remove the sheets of gold, cut each into four pieces and place between the leaves of a "mould" consisting of 950 of the finest goldbeaters' skins 5 inches square. Beat four hours with a seven-pound hammer.

An ounce of gold will produce 1,200 leaves which will trim to squares 3⅜ inches on a side. Thus one ounce will produce about 150 square feet of gold leaf. The goldbeaters' skin consists of the outer coat of the caecum or blind gut of an ox. A skin lasts for about 200 beatings.

Recovery of Gold

It is not the purpose of this paper to discuss the technical details of the recovery of gold from the earth or its subsequent treatment, but a few facts may be of interest.

[5] Chicago: University of Chicago Press, 1951.

Among the metals, gold alone is found predominantly in the native or uncombined state. Copper is occasionally found in the metallic state but with the notable exception of the Michigan deposits its occurrence in that form is in relatively small amounts and at widely separated locations. Bismuth, mercury, and silver are found at widely separated spots in the metallic state; and a few small meteorites consist of iron-nickel alloy. Although gold is one of the rare metals, it is found in all parts of the world and nearly always as metal, although sometimes alloyed with small amounts of silver and copper.

During millions of years of geologic time, mountain ranges have been eroded to an incredible degree and vast amounts of gold-bearing rock have been disintegrated by chemical action and abrasion in both modern and prehistoric streams. During this action the gold, being soft rather than brittle, was freed from the associated rock in particles of varying size and shape and because of its high specific gravity it tended to lodge in stream beds or at the bottom of sand and rocky debris washed down from the mountains, often many miles away. The first gold found by our prehistoric ancestors was undoubtedly in the beds of flowing streams, and modern man is still industriously working over the gravel deposited by both ancient and existing streams.

The original deposits of gold in the earth's crust are in veins running through quartz or other rock or in deposits of sulfide minerals of copper, lead, and zinc. In all these cases, as previously stated, the gold is usually in the metallic state either as long stringers, lumps, or fine powder. The only mineral compound is the telluride which is of minor importance measured against the total supply, but is locally important in some mining districts.

It is impossible to tell when man began to secure gold by rock mining but it probably did not occur in the true sense until after iron tools became available. Outcroppings of gold veins may have been worked to slight depth by heating the rock with fire and quenching suddenly with water. This is known to be one of the earliest methods for disintegrating rocks.

Early mining methods were crude and the operations dangerous due to lack of safety devices and good engineering methods. The excavations were narrow and crooked, and poorly ventilated. The miners were nearly all slaves and because of the danger and hardships, the slaves were often assigned to the mines as a means of punishment.

The rock removed from the ground was broken by heating and quenching, or by crude hand methods until the gold was freed. Over the centuries procedures for mining and crushing improved but it was not until slave labor became scarce that any rapid improvement was made in these directions.

Man has always learned how to do things by observing nature or other human beings and trying to imitate the operations. Primitive man observed how particles of gold lodged in crevices or low spots in a stream bed. He imitated nature by shaking a batch of gold-bearing sand in water until the gold settled to the bottom, and then slowly and carefully washed away the barren top sand until the gold (with possibly some heavy minerals) remained. Hundred of modifications and improvements of this procedure have been developed and used from time to time, but the same principle is used in the most modern equipment.

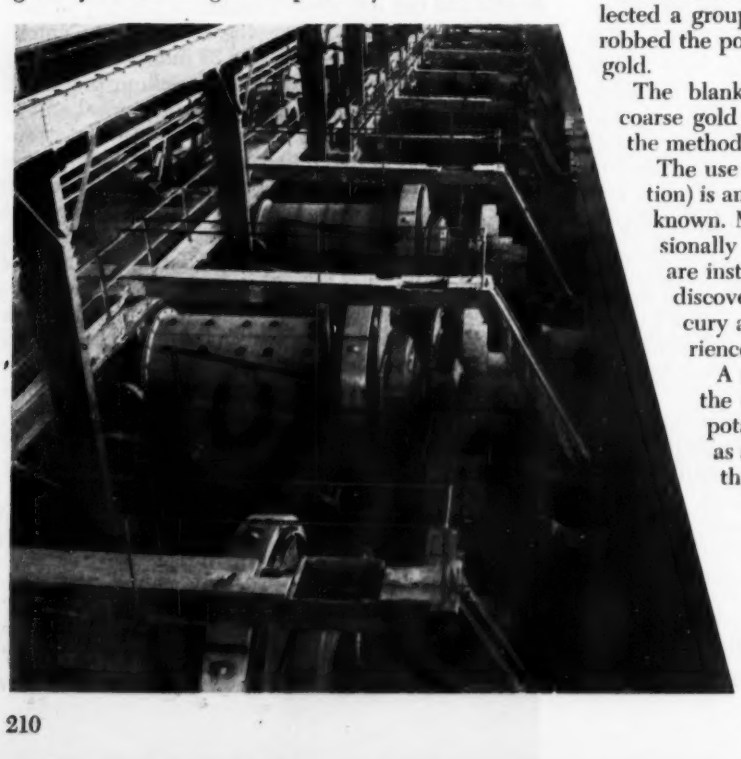
The legend of Jason and the Argonauts, dated about 1263 B.C., can be told in modern terms as follows. It was learned that the Armenians were recovering gold by washing sand and gravel through inclined sluiceways in the bottom of which were placed sheepskins with the wool side up. The gold was caught in the wool and periodically the skins (golden fleece) were removed and the gold washed out. Jason collected a group of buccaneers, went to Armenia and robbed the poor miners of their arduously recovered gold.

The blanket tables used today for recovering coarse gold from crushed ore are but a step from the method used in Jason's time.

The use of mercury to absorb gold (amalgamation) is ancient, although the date of origin is not known. Mercury is one of the few metals occasionally found in the metallic state, and there are instances of a natural gold amalgam being discovered. It is possible that the use of mercury as a collector of gold sprang from experience with this alloy.

A new era in gold production came with the commercial use of a weak solution of potassium cyanide (later sodium cyanide) as a solvent for gold and its application to the extensive gold deposits in the Trans-

(*Continued on page 216*)



These grinding mills at the Homestake Mining Company in Lead, S.D., grind the ore from the mine preparatory to leaching out the gold with cyanide solutions.

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Electronics Heads

THE appointment of two associate directors for the Research Laboratory of Electronics at M.I.T. has been announced by Julius A. Stratton, '23, Provost. They are George G. Harvey, Associate Professor of Physics and formerly Assistant Director of the Research Laboratory of Electronics, and Henry J. Zimmermann, '42, Associate Professor of Electrical Engineering and staff member of that laboratory. Both will continue their long association with Professor Jerome B. Wiesner whose appointment as director of the Research Laboratory of Electronics was announced last summer.

Dr. Harvey is well known for his studies on x-ray scattering and atomic structure and for his research in electron microscopy. He is the author of a number of scientific articles which have appeared in the *Physical Review* and the *Journal of Chemical Physics*.

Born in St Louis, Mo., in 1908, Dr. Harvey was educated at Washington University, where he was awarded the degrees of bachelor of arts in 1928, master of science in 1930, and doctor of philosophy in 1932. From 1932 to 1934 he was a National Research Council Fellow in physics at the University of Chicago, and was appointed instructor in physics at M.I.T. in 1934. From 1937 to 1938, he was an instructor in physics at the College of the City of New York. Dr. Harvey returned to M.I.T. in 1938 as assistant professor, became an associate professor of physics in 1943, and in 1950, the executive officer of the Department of Physics.

During World War II, Dr. Harvey served for four years as a staff member of the Radiation Laboratory at M.I.T. In 1944 and 1945 he was a scientific consultant for General Headquarters (Southwest Pacific Area) and the Research Section of the United States Armed Forces (Far East) under the Office of Field Service of the Office of Scientific Research and Development which was created in 1941.

Dr. Harvey is a Fellow of the American Association for the Advancement of Science and of the American Physical Society, as well as of the Physical Society of London. He is a member of Phi Beta Kappa and Sigma Xi fraternities.

Professor Zimmermann has been a member of the Institute's teaching staff since 1940 when he was appointed a research assistant in the Department of Electrical Engineering. He was named instructor at M.I.T. in 1942, assistant professor in 1946, and associate professor in 1948. Since 1947 he has been on the staff of the Research Laboratory of Electronics where he has served as supervisor of a research team.

Born in St. Louis in 1916, Professor Zimmermann received the degree of bachelor of science from Washington University in 1938, and the degree of master of science in electrical engineering from M.I.T. in 1942.

From 1938 to 1940 he served at Washington University as an instructor in electrical engineering. During this period, Professor Zimmermann carried out research on sensory aids for the Central Institute for the Deaf, and developed an electronic device to present a visual indication of pitch for use in teaching voice inflection to the deaf.

During World War II, Professor Zimmermann helped to organize radar training courses at M.I.T., for Army and Navy officers. These courses led to the establishment of the M.I.T. Radar School, where from 1941 to 1946 Professor Zimmermann served successively as instructor, supervisor of Army courses, and assistant director of the school. He is a member of Tau Beta Pi and Sigma Xi, the Institute of Radio Engineers, as well as the American Institute of Electrical Engineers.

Westward, across the Atlantic

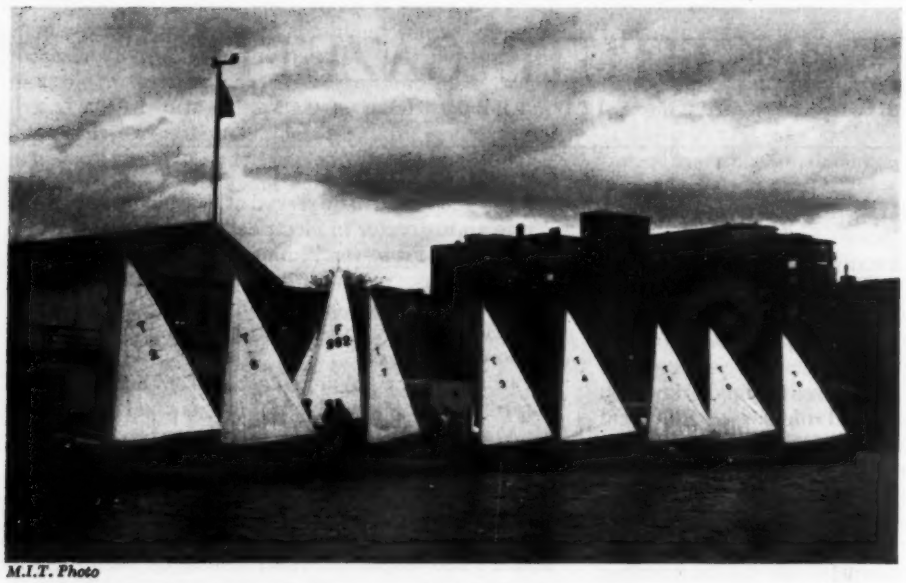
TWO distinguished British educators have been appointed to visiting posts on the Institute's Faculty. Ewart R. H. Jones has been named Arthur D. Little Visiting Professor of Chemistry, and John Jewkes, Professor of Economic Organization at Oxford University, has been appointed Visiting Lecturer in Economics at M.I.T.

Professor Jones was educated at Grove Park School, Wrexham, and at the University College of North Wales. He received the degree of doctor of philosophy from the University of Wales in 1936, and the degree of doctor of science from the University of Manchester in 1944. While at M.I.T. he will be on leave from the University of Manchester, where he is Sir Samuel Hall Professor of Chemistry.

Professor Jones's published work embraces a number of fields including steroids, vitamin A, triterpenes, acetylenes, and plant-growth hormones. In 1940 he received the Meldola Medal, a distinguished award presented annually by the Royal Institute of Chemistry to the young chemist who has made the most meritorious contribution to chemistry. He was named a Fellow of the Royal Institute of Chemistry in 1944, and a Fellow of the Royal Society in 1950.

The professorship which Dr. Jones holds at M.I.T. has been established out of a bequest of funds left to the Institute by the late Arthur D. Little. Dr. Little, a graduate of M.I.T. in 1885, was widely known for his outstanding pioneering in the application of science to industry.

Professor Jewkes comes to the Institute under the joint sponsorship of the School of Industrial Management and the Department of Economics and Social Science. He was at M.I.T. for a month, beginning November 24, and during this period conducted a number of seminars with students, as well as consulting with members of the Faculty.



The wear of a decade and a half of continued use last year necessitated replacement of the fleet of dinghies which, since 1936, has enabled M.I.T. to take a leading part in intercollegiate sailing. A portion of the new fleet is shown at the M.I.T. Sailing Pavilion. The new boats, designed by Professor Emeritus George Owen, '94, are built of Fiberglas. They sail well, are well liked, and in the opinion of Walter C. Wood, '17, Sailing Master, should be easier and less expensive to maintain than the original wooden boats.

M.I.T. Photo

Professor Jewkes has held his post as professor of economic organization at Oxford since 1948, and is a Fellow of Merton College. He was educated at the Barrow Grammar School and at Manchester College, where he served as a lecturer in economics from 1926 to 1929. During the following year he held a Rockefeller Foundation Fellowship. From 1936 to 1946 he was professor of economics at Manchester University, and for the following two years he held the Stanley Jevons Professorship of Political Economy. In 1941 he was director of the Economic Section of the War Cabinet Secretariat, and in 1943 he was appointed director-general of statistics and programmes in the Ministry of Aircraft Production. He was made principal assistant secretary, Office of Minister of Reconstruction, in 1944, and became a member of the Fuel Advisory Committee the following year. In 1946 he was an independent member of the Cotton Industry Working Party, and served as a member of the Royal Commission on Gambling, Betting and Lotteries in 1949.

Midwinter Meeting

ROYAL BARRY WILLS, '18, chairman of the Midwinter Meeting Committee, reports that plans for the annual event in Walker Memorial on Thursday, February 5, 1953, have been completed. Karl T. Compton, chairman of the M.I.T. Corporation, and Professors Harold E. Edgerton, '27, and Edward R. Schwarz, '21, will take part in the program at which George R. Harrison, Dean of the School of Science, will be toastmaster. This meeting, featuring progress in photography high speed and textiles, will begin with a steak dinner at 6:00 P.M. Prior to the meeting, facilities of the M.I.T. Faculty Club (50 Memorial Drive) will be available to Alumni attending this meeting.

Alumni of Metropolitan Boston are urged to attend this annual event at Technology, and to bring as their guests, boys of high school age for whom the program is expected to have great interest.

Geology and Geophysics

A WIDE range of problems of importance to the Department of Geology and Geophysics was discussed on April 22, 1952, when the Department's Visiting Committee met at the Institute.* Members who attended were: Robert T. Haslam, '11, chairman, E. L. DeGolyer, Alfred T. Glassett, '20, Cecil H. Green, '23, and Robert B. Sosman, '04. In addition, the following administrative officers of the Institute were present: James R. Killian, Jr., '26, President; Julius A. Stratton, '23, Vice-president and Provost; George R. Harrison, Dean of the School of Science; Walter H. Gale, '29, Secretary; and Professor Robert R. Shrock, Head of the Department of Geology and Geophysics.

The Administration recently approved the Department's request for a change of name to the Department of Geology and Geophysics. This change was requested because the students now enrolled in Course XII, as well as those approved for the year 1952-1953, are about evenly divided between the present options, geology and geophysics, and also because the Department has requested the Administration to approve changing these options to separate courses.

The discussion then turned to consideration of the major problems to be worked out by the Department.

The first and most important problem now facing the Department is that of insuring a steady flow of good students into the Department upon completion of their freshman year. For the year 1951-1952 a total of 10 sophomores entered Course XII, and for the year 1952-1953 this number has been raised to 12. These figures are not far from the optimum of 12 to 15 students per year, but Dr. Haslam emphasized the thought that every effort should be made to assure a steady flow of sophomores in the study of geology and geophysics. It was also pointed out that Technology

* Members of this Committee for 1951-1952 were: Robert T. Haslam, '11, chairman, Godfrey L. Cabot, '81, Louis S. Cates, '02 (replaced by Alfred T. Glassett, '20), Robert B. Sosman, '04, Cecil H. Green, '23, Guillermo Zuloaga, '30, and E. L. DeGolyer.

Alumni throughout the country, if better informed about the work now going on at the Institute in geology, might be quite helpful in interesting local high school students in pursuing geological studies at M.I.T.

Next in importance to the Department is the need to maintain an adequate flow of graduate students, and to assure that qualified students are financially able to continue their studies. Dr. Shrock stated that 37 graduate students have been admitted to the Graduate School for study in the Department of Geology and Geophysics for the year 1952-1953, and that these constitute the largest and most promising group of graduate students ever admitted to the Institute for work in the Department. Although this graduate group is the largest ever, every effort must be made now and in the future to assure a steady flow of the best possible graduate students into the Department. It was pointed out that of these 37 students, 30 will be supported financially in one way or another, and that three of the remaining seven need financial assistance of some kind. This situation emphasizes what seems to be a general condition throughout the country; namely, that most graduate students need financial assistance of some kind, and they will tend to go where they can get it. It behooves the Institute, therefore, to make every effort to find ways by which it can partly, or fully, support high-quality graduate students while they carry on their program of instruction and research leading to advanced degrees.

The third problem facing the Department and anticipated in the preceding discussion is that of raising funds for the support of graduate students and for the purchase of experimental and instrumental facilities needed for these students and for staff members to carry out the fundamental research that has become an important part of departmental operations. It is the Department's feeling that every effort should be made to find endowment funds of some sort to make it possible to plan research on a long-range basis, independent of government funds.

The final problem facing the Department is that of finding a geologist and at least one geophysicist to round out the instructional staff. The members of the Visiting Committee feel that the two courses of study (geology and geophysics) are about as good as can be offered at the present time, if the Department wishes to train undergraduates in basic science along with geology or geophysics. Most of the Committee felt that this kind of program should be carried on at M.I.T. because of the unique opportunities provided by the close liaison of the Departments of Mathematics, Physics, Chemistry, and Geology, and furthermore because there is at M.I.T. a strong tradition favoring extensive training in the fundamentals of science as a basis for any professional field. It was felt that such a program was advisable even though it did not produce bachelors who were sufficiently specialized to enter any particular field with much detailed knowledge of how things were done in that field. One member of the Committee, however, felt that the present program in geology too strongly emphasized mining or "hard-rock" geology, and was not as complete as might be desired for the training of petroleum or "soft-rock" geologists. For the present, greater emphasis on petroleum geology is deferred until a satisfactory appointment can be made for an opening in the Department.

There seemed to be a consensus that every effort should be made by all interested parties to inform the public more fully about the two programs the Department now has in operation, and about the needs of the Department, in terms of students, funds and personnel, to continue to improve its program of instruction and research. As a part of this program of informing the public, several means were suggested – an informative booklet, lectures to students and the general public, improved exhibits, papers at meetings, participating in conferences and symposia, sending out of reprint lists at regular intervals.

The report of the Visiting Committee was presented at the October 6, 1952, meeting of the M.I.T. Corporation, and at the October 24 meeting of the Executive Committee. On November 19, material was received for publication in The Review.

Jobs for Students and for M.I.T.

RAYMOND H. BLANCHARD, '17, presided as chairman of the Visiting Committee on the Division of Industrial Coöperation at its two-day meeting at the Institute on March 26 and 27, 1952. In addition to members of the Visiting Committee,* 11 members of the Institute's Administration took part in these meetings, at one time or another, to offer reports or discuss special phases of the D.I.C. activities. The report of the Visiting Committee, reviewed at the October 6, 1952, meeting of the M.I.T. Corporation and the October 24 meeting of the Executive Committee, was received for publication in The Review on November 19.

The problems of Student Placement, Alumni Placement, and the contract-research activities of the Division of Industrial Coöperation were carefully reviewed by the Committee who heard reports from: Nathaniel McL. Sage, '13, Director; F. Leroy Foster, '25, Associate Director; Professor Carlton E. Tucker, '18, in charge of Student Placement; Mrs. Evelyn B. Yates, in charge of Alumni Placement; as well as from James R. Killian, Jr., '26, President of M.I.T.

Reporting on the placement of graduates, Professor Tucker stated that the Institute maintains an active program of obtaining employment for students upon graduation, in spite of the present heavy demand for engineers, especially in the fields of electrical, mechanical, and chemical engineering. During the spring of 1952, it was usual for from six to 12 representatives from industrial concerns to visit the Institute daily to interview students for positions in industry; in some cases as many as 18 personnel representatives were accommodated in a single day. It is the practice of industrial representatives to announce their visits about two weeks in advance, and for the Placement Advisers in each department of the Institute to prepare lists of suitably qualified men who are available for employment so that they may be interviewed by personnel representatives from industry. By making such a preliminary screening, the Placement Bureau saves

* Members of this Committee for 1951-1952 were: Raymond H. Blanchard, '17, chairman, John W. Crowley, Jr., '20, William J. Sherry, '21, Thomas H. West, '22, Isaac Harter, Beauchamp E. Smith, and Irvin Stewart.

the time of students and of visiting personnel industrial representatives, and maximizes the probability of finding the right student for the right job. As compared to 235 companies who visited the Institute during 1950, some 400 companies sent representatives to M.I.T. during 1951-1952, Professor Tucker stated.

As Alumni Placement Officer, Mrs. Yates reported that there is virtually no unemployment among M.I.T. graduates, although approximately 850 graduates register each year with the Alumni Placement Office in order to be available for better positions than those they now hold, or to take positions in different parts of the country. The problem of relocation is easy for those earning less than $600 per month, but considerable time and effort are still required to make worthwhile changes at this salary or more. The demand for Technology Alumni is about four times as great as the number of men available for any kind of change in their professional work, and there is no sign that this demand will slacken in the near future.

In reporting on the research activities of the Division, Mr. Sage reminded the members of the Committee that the D.I.C. is highly decentralized and that while it administers the business phases of research contracts with the Institute, the technical aspects of contract research rest with members of the Institute's Faculty, except in rare instances. Members of the Committee were favorably impressed with the efficient administration of an extensive and complex activity, but expressed concern with the fact that an exceedingly large part of the dollar value of the Institute's contract research is done, directly or indirectly, for the United States Government. The Committee felt it desirable to achieve a greater diversification of sponsorship of research contracts and recommended that serious consideration be given, and future planning be made, to meet new conditions that may be expected to arise in the termination or withdrawal of the large volume of government development contracts.

On the afternoon of March 26, President Killian discussed with members of the Visiting Committee, the nationwide shortage of engineers. In aiming to attract the best qualified students to the Instiute, President Killian pointed out that M.I.T. faces competition from other schools who offer higher subsidy through scholarships. Plans for obtaining additional funds for scholarship aid for outstanding students were also outlined by Dr. Killian.

In view of the great need for additional graduate engineers, the Committee recommended that M.I.T. expend every effort to increase its freshman class, commensurate with the facilities for properly instructing entering students, and without lowering standards in the training of students during their four years of study at the Institute.

The Committee concluded that an excellent job is being done in both Student and Alumni Placement activities. On the basis of comparisons with other colleges, who are making good records in placement work, it appears that the Institute is doing an outstanding job among colleges and universities in this field.

The Committee also concluded that the Division of Industrial Coöperation is being capably administered by an extremely versatile and enthusiastic organization of minimum size for the work being done. The Division is to be particularly commended for the efficient and smooth-working relationships which have been established with the government and industry in all phases of the administration of contract research.

Defense Laboratories

THE size of the Lincoln Laboratory and its anticipated removal from the M.I.T. campus to Bedford have led to a decision to separate this project administratively from other activities of the Division of Industrial Coöperation.

To accomplish this separation and to provide Lincoln Laboratory the fullest support, the Executive Committee of the Corporation has approved a new administrative unit of the Institute to be known as the Division of Defense Laboratories. This Division, established in January, will assume the responsibility for all Institute services necessary for the management and support of Lincoln Laboratory. The over-all direction of Lincoln Laboratory will continue to be the responsibility of Professor Albert G. Hill, its Director. The new Division will provide the fiscal support and co-ordination of services and policies which the Division of Industrial Coöperation provides for its projects. The organization and procedures of the new Division will therefore parallel those of the Division of Industrial Coöperation, and its administrative relationship to the Institute will be the same as that of the Division of Industrial Coöperation.

Horace S. Ford, Treasurer Emeritus and a life member of the Corporation, will serve as acting director during the formative period of the Division. The associate director will be Paul V. Cusick who remains assistant director and fiscal officer of the Division of Industrial Coöperation.

Executive Development Program

THE long-established Executive Development Program, covering one year of advanced study in industrial management at M.I.T. will be substantially expanded in 1953–1954. E. P. Brooks, '17, Dean of the School of Industrial Management, has announced plans for the 1953–1954 program and for the Sloan Fellowships which will be awarded. The fellowships, he said, will be given to young industrial executives who have already demonstrated their ability to grow into major management responsibilities and who are assured of opportunities for constructive leadership in their companies.

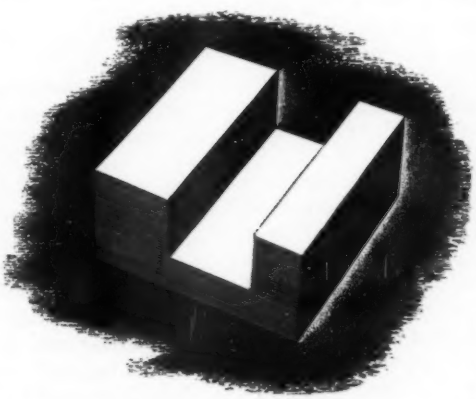
With an increase by the Alfred P. Sloan Foundation, Inc., in the funds available, the Executive Development Program will in 1953–1954 serve two groups of 15 to 18 fellowship recipients. A nationwide competition for fellowships will close this year on February 21, 1953.

Participation in the Executive Development Program is limited to recipients of Sloan Fellowships. Nomination by an employer is a prerequisite, since employers co-operate in the program by sponsoring these men and by providing successful candidates with a year's leave of absence and financial aid. Gerald B. Tallman, Associate Professor of Marketing, is director of the Sloan Fellowship Program.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

From time to time Revere, through its advertising, its salesmen, its Technical Advisors, and its printed literature has stressed the fact that cost per pound of material is not so important as cost per finished part. It is actually the case that sometimes metal that has to be billed at a higher price, either because of its form or its composition, actually effects savings that much more than compensate for the extra cost.



Perhaps as a result of the educational work we have done on this subject, an alert purchasing agent for one of our customers inquired as to the possibility of switching from bar stock to an extruded shape. The Sales Department and the Technical Advisory Service collaborated with the purchasing, engineering and production people, and a plan was worked out, which is saving important sums.

The company makes electric welding machines, and the part involved is called a secondary pad. It is made of copper, for high conductivity. Previously it had been machined out of solid bar stock, 2" x 3½". This was costing $11.73 per foot.

The extruded shape that was substituted for it weighs 25% less. The cost per foot is $10.03, which represents a saving of $1.70 per foot. You can see right from those figures that paying a little more per pound for the extruded shape saves money. But in addition to that, the customer estimates that the shape has cut machining time by 50%, and as every manufacturer knows, machining is costly, and cutting it in half achieves a significant economy. Other advantages include less scrap, and faster output. A report from a Revere Technical Advisor states: "Customer has found the extruded section very satisfactory and bases his machining time-saving on production runs and not estimates".

Extruded shapes are made by forcing heated metal through a die of the desired profile, much like squeezing toothpaste from a tube. This offers unique opportunities for an infinite variety of shapes; the one shown here is simple; much more complex forms are possible. There is an obvious limitation: all grooves and slots must be parallel to the axis of extrusion. If you are doing any extensive machining of rod or bar in copper and its alloys, or aluminum alloys, a Revere salesman will be glad to consult with you regarding the possibilities of extruded shapes. They cost a bit more per pound, but in the end may save you money.

As a matter of fact, it is true in many industries that a material that costs more per pound or ton or gallon may actually in the end cost less. So we would like to suggest that no matter what you buy for processing, it is possible that by paying a little more for something special you might save a lot.

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GOLD
IN FACT, FICTION, FINANCE

(*Continued from page 210*)

vaal. The gold is readily precipitated as metal from the cyanide solution by the addition of metallic zinc dust and recovered by filtration. This process put Africa far in the lead as a gold producer, a position which still remains unchallenged.

The solvent power of cyanide solution for gold was known in 1863 but for some strange reason no important commercial application was made until after 1890. The importance of the method lies in the fact that large amounts of finely crushed or ground material containing as little as 0.1 ounce of gold per ton may be treated profitably, whereas only relatively rich ores are suitable for profitable treatment by amalgamation.

Discovery and Production of Gold

Gold was discovered in California in January, 1848, and in Australia in February, 1851. These events gave a great impetus to the hunt for gold by free men. Various other discoveries of major or minor importance have been made since then from time to time but, except for the Klondike rush in 1899, they have not claimed the attention of large masses of the population.

The development of the gold mines in the Transvaal began in the 1880's. These mines are in very hard rock and have been driven in some cases to well over a mile in depth requiring heavy investments and great engineering skill. The amount of the Russian output is high but the exact production is not known. Exploration of the gold-bearing areas of Canada is being carried on systematically and the output is increasing at a rapid rate. The six leading producers of gold, in 1891 and in 1949, are given in the following table with production given in troy ounces:

	1891	*1949*	
U.S.A.	1,317,700	1,921,949	
Australia	1,247,306		
Russia	871,060	7,000,000	*(estimated)*
South Africa	567,100	11,705,048	
Canada		4,103,856	
All Others	2,764,500	5,800,000	
World Total	6,767,666	30,530,853	

In 1492 the annual rate of the world's production of gold was about 186,000 ounces and rose gradually, with minor fluctuations, until it reached about 650,000 ounces in 1847. The discovery of gold in California, and soon after in Australia, caused the production to rise sharply to nearly 10 times this figure in 1856. From this point there was an irregular decline to about 4,643,000 ounces in 1883, followed by a slow rise to 1893 when it again approached the 1856 production. Then came the introduction of the cyanide process, the increasing importance of the South Africa mines, the Alaska rush, and the development of Canadian mines, all of which resulted in a peak output of 15,036,000 ounces in 1899. Several years of fluctuation followed until another peak of 22,606,000 ounces was reached in 1912. An all-time high was reached in 1940 with 41,216,000 ounces, after which production declined to 30,600,000 ounces in 1949.

The total world's production of gold, from the discovery of America in 1492 to and including 1949, is approximately 1,656,065,000 troy ounces. Of this amount 1,168,229,000 ounces, or about 70 per cent, have been produced in the present century. The weight of a cubic foot of gold is 1,206 pounds or 17,587 troy ounces. It follows, therefore, that the world's production of gold from 1492 to 1949 amounts to 94,221 cubic feet or, in round numbers, a cube having an edge of 46 feet. The gold produced at the 1940 peak would occupy 2,344 cubic feet or a cube about 13⅓ feet on a side.

At $35.00 per ounce the total value of the gold produced in 1949 amounts to $1,071,000,000, and for the total production from 1492, to and including 1949, the value is $57,962,275,000 – which wouldn't go far in paying the expenses of the United States Government for one year.

Gold-plated Bathtubs!

It is interesting to speculate on what uses would be made of gold if it were relatively abundant and cheap, so that, for example, it might be on a commercial par with copper. Its competitive position would doubtless depend on its properties, the most outstanding of which are its ductility and resistance to corrosion. Gold would undoubtedly be used extensively for sheets and tubes, and for gold-plating. Our plumbing would be largely of gold, gold alloys, or gold-plated material. We might not go so far as to pave our streets with it but it would be valuable as a roofing material and for similar uses. Would it still be used for jewelry to ornament one's person? Probably it would not – for what lady would want to burden herself with rings of such cheap material?

Monetary Gold

The gold standard, or the official use of gold as a basis for other currency, was established in England in 1816, and similar action was taken by the United States in 1873. An adequate discussion of the merits of the gold standard and the objections to it would require space far beyond the bounds of this article, and it would be presumptuous for a metallurgist to undertake it. By mere chance the writer was a spectator in the New York Stock Exchange in September, 1931, when the news was received that England had abandoned the gold standard, and the memory of the excitement which the announcement produced is still vivid. The United States did not abandon the gold standard until April, 1933, as most of the readers of The Review will recall.

In the present chaotic condition of the world, it would be difficult to re-establish gold as a basis for currency under conditions which would be generally acceptable to the financiers of the leading nations. It is argued by some that insufficient gold exists in the world for this purpose, and this argument has been answered by the suggestion that some combination of gold, silver, and platinum might be used. If this recalls

(*Continued on page 218*)

Massachusetts Institute of Technology

SPECIAL SUMMER PROGRAMS

for professional personnel from industry, government and educational institutions

Strength of Materials	2 weeks	July 6–July 17
Industrial Photoelasticity	2 weeks	Aug. 10–Aug. 21
Strain Gage Techniques	1 week	Aug. 24–Aug. 28
Aerodynamic Measurements	2 weeks	June 16–June 26
Lubrication Engineering	2 weeks	June 16–June 26
Thermodynamics	2 weeks	June 29–July 10
Product Design	2 weeks	July 6–July 17
Fluid Power Control	2 weeks	July 6–July 17
Metal Cutting	2 weeks	June 16–June 26
Textile Research	4 weeks	July 6–July 31
Casting Light Metals	1 week	Aug. 31–Sept. 4
Physical Metallurgy	2 weeks	June 16–June 26
City and Regional Planning	2 weeks	Aug. 24–Sept. 4
Science Teachers Program	6 weeks	June 29–Aug. 7
Electrical Methods of Instrumental Analysis	1 week	Aug. 17–Aug. 21
Optical Methods of Instrumental Analysis	1 week	Aug. 24–Aug. 28
Technique of Infrared Spectroscopy	1 week	July 6–July 10
Applications of Infrared Spectroscopy	1 week	July 13–July 17
Digital Computers and Their Applications	2 weeks	Aug. 24–Sept. 4
Feedback Control Systems	2 weeks	June 22–July 3
Transistors and Their Applications	2 weeks	July 20–July 31
Noise Reduction	2 weeks	Aug. 24–Sept. 4
Occupational Health, Management Responsibility for	1 week	June 22–June 26
Operations Research	3 weeks	June 16–July 3
Control Problems of the Executive	3 weeks	June 16–July 3
Automatic Control of Aircraft	2 weeks	Aug. 24–Sept. 4
Food Technology	3 weeks	June 29–July 17
Math. Problems of Communication Theory	1 week	July 6–July 10

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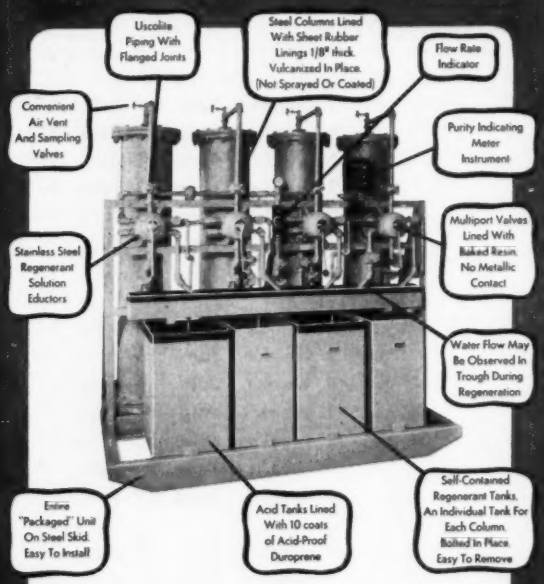
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GOLD
IN FACT, FICTION, FINANCE

(*Continued from page 216*)

the reaction to William Jennings Bryan's "Cross of Gold" speech at the Democratic Convention in 1896 and his campaign for coining both silver and gold in the ratio of 16 to one, it might be suggested that other radical ideas of Bryan's time are now accepted as sound. There is much to be said in favor of a metallic base for currency, and its re-establishment is worthy of further consideration as we try to smooth the way for international trade.

Even in these days when the great powers all conduct their internal affairs without the use of gold coins, it is worthy of note that gold bullion is still transferred from country to country in an attempt to balance the exchange. This is recognition of the fact that, unofficially, gold is still considered as a monetary factor.[6]

The movement of gold to the United States became very heavy after the price was raised to $35.00 per ounce by decree of President Roosevelt, on January 31, 1934. At that time an interesting remark was made to the writer by Colonel Samuel C. Vestal, then Head of the Department of Military Science at M.I.T. Colonel Vestal stated that one of his friends in Washington had written that among the gold shipments received from France were some, still in the original packages, that had been sent across the Atlantic by this country for the Louisiana Purchase.

In 1937, the United States mint estimated the total world's monetary stocks of gold to be $23,000,000,000 at $35.00 per ounce, of which this country held more than $11,000,000,000. On October 18, 1938, the United States stock had risen to $14,008,236,361, which is well over 10 times the total estimated amount of gold in the world in 1492.

Golden Opportunity

No general discussion of gold would be complete without reference to the attempts throughout all history to produce gold from other substances. Mythology tells of King Midas who prayed to the gods for power to transform into gold everything he touched, and soon discovered that this power brought more trouble than benefits. His prayer to have the power removed was answered by the command to wash in the river Pactolus. The considerable amount of placer gold extracted in later years from this stream was ascribed to this event. The gold accumulated by Croesus came principally from the river Pactolus.

The determination of gold in ores by means of fire assaying has been standard practice for 300 years or more, and metallurgical extractions have conformed closely to the results obtained by this procedure. In spite of this, men have appeared from time to time who claimed to have discovered procedures which

(*Concluded on page 220*)

[6] Numerous discussions of the role of gold in international economy have appeared during the past two decades. For a brief modern discussion the reader is referred to a series of articles by J. P. de Wet, appearing in the March, April, May, and July, 1952, issues of the *Canadian Mining Journal*.

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GOLD
IN FACT, FICTION, FINANCE

(*Concluded from page 218*)

gave higher results than those shown by fire assaying. The writer has known several such persons. The most recent was a man who claimed that the rock adjacent to gold veins contained large quantities of gold which had not yet assumed the atomic form. He claimed to have a procedure of electron bombardment whereby gold atoms would be formed after which the metal could be recovered by usual methods. He stated that the British government was trying to prevent its use for fear of destroying the pre-eminent position of the British Commonwealth in gold production.

Destiny of Gold

The principal objective of the alchemists was to transmute base metal into gold, and even in modern times innumerable procedures have been suggested. Any day now some nuclear physicist may startle the world with an announcement along this line.

However, we need not worry over these problems, for gold seems destined to remain scarce and expensive, unless some genius succeeds in extracting it economically from sea water. The oceans of the world, according to the *Encyclopaedia Britannica*, contain about 10 billion tons (yes, tons) of gold waiting for someone to get it out. Perhaps it is this gold which will be used to pave the streets of the New Jerusalem.

SCIENCE PUBLICITY

(*Continued from page 206*)

Many scientists of very mature judgment believe there has been a very serious decline in the popularity of their profession during the past few years. They have begun to feel themselves subject to public suspicion, recrimination, and fear. Their loyalty is questioned, their internationalism is frowned on, and their interest in the work of colleagues in Iron Curtain countries is made to seem little short of treason.

A knowledge of the tactics and strategy of science helps to interpret these things properly. Exchange of information is an essential to scientific progress, and international boundaries have no inherent relation to this process; scientists in Russia and East Germany may have as much to contribute to the question of cancer as those in Japan or Sweden. When suspicion attaches itself to the practice of internationalism, then scientists must expect to be viewed with suspicion.

There is no doubt that some scientific and engineering laboratories now need to be protected from espionage on the basis of their contributions to national security. In these cases, no one will argue against "clearances" to make sure that the laboratory workers are men of loyalty and sound judgment. But this, too, has its dangers to scientific enterprise. Scientists are especially jealous of what Kirtley F.

(*Continued on page 222*)

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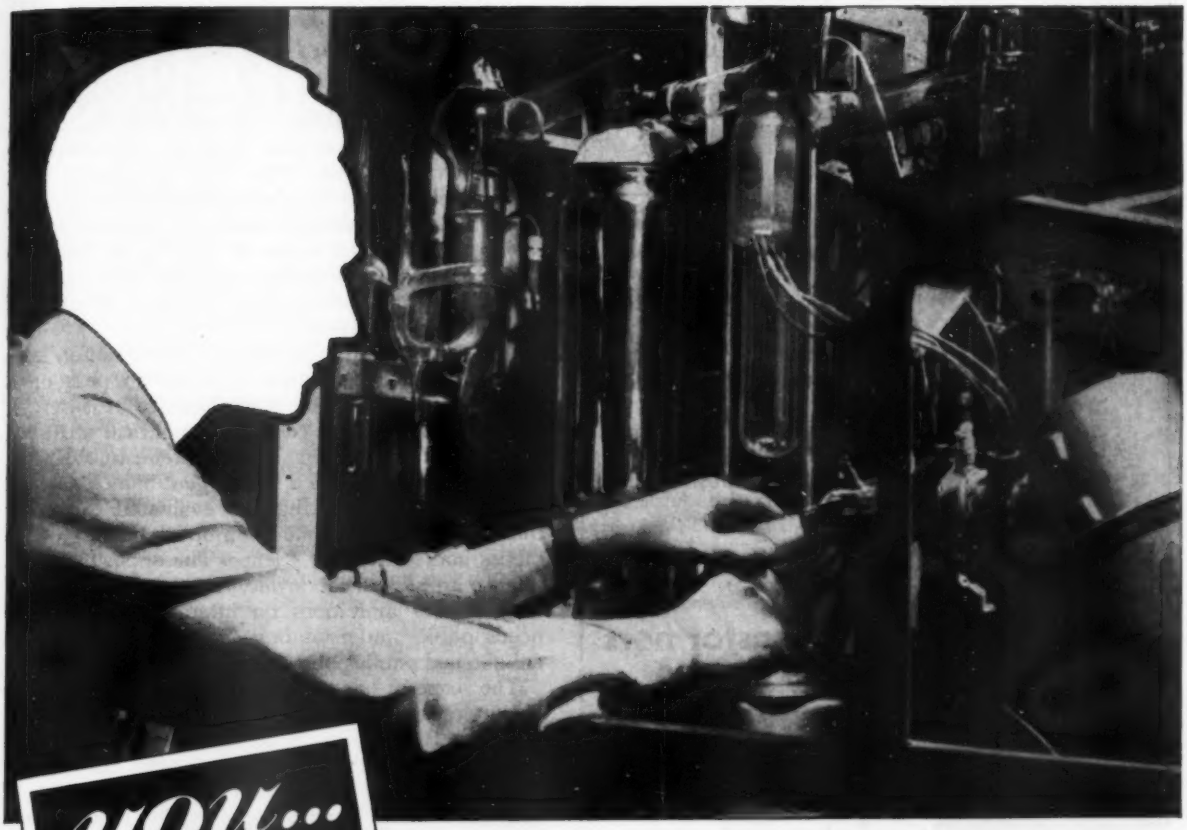

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SCIENCE PUBLICITY

(*Continued from page 220*)

Mather calls "the one most important freedom of all, the freedom to think one's own thoughts and to express them so that they may be appraised" by their own colleagues. This free interchange and intellectual integrity is a basic ingredient of science; any semblance of thought control is resented by any scientist because he knows it will blight his intellectual activities. Scientists are not alone in this abhorrence, but perhaps they are more deeply and critically involved than most of us.

Says Dr. Gellhorn: "It may be that the nation loses more than it gains when, in order to pass on a scientist's eligibility to participate in research, it seeks to examine and confine his political attitudes, his personal associations, and his intellectual drifts."[9] The question, and it is a very urgent one of national policy, cannot be intelligently evaluated except by those who have, once more, an understanding of the tactics and strategy of science. The opposition from science to superficial loyalty checks, extensions of secrecy, and limitations on international exchange needs public understanding from which may come enlightened public policy.

The scope of our problem is becoming clear. "We cannot escape the necessity of giving thought and effort to the conditions under which science and scientists make their contributions to the world's progress," E. U. Condon told the 1952 meeting of the American Chemical Society in Buffalo, and stated: "These conditions are not good in America today." But the question of how we may proceed is less obvious. In 1940, Vannevar Bush, '16, concluded that "science can be interpreted effectively only for those who have more than the usual intelligence and innate curiosity." To this gloomy prediction our democratic society must, somehow, take exception, now that science has become so vastly dependent upon public affairs for a constructive and understanding environment.

The required solution is a matter of education, and schools and colleges everywhere are studying how best to contribute to these new needs. Most college freshmen are now exposed to a general education program, the science phase of which is designed primarily to develop an understanding of the tactics and strategy of science. In high schools the situation is less favorable; the problem is less understood, the resources are fewer, and a very small proportion of students come into contact with courses of any kind worthy of being identified with serious science. Formalized adult education programs are a very meager power in today's busy living.

Newspapers, magazines, radio, and television remain the sources from which most citizens will acquire their facts and impressions about scientific affairs. This acquisition is a subtle process about which we know very little. But the challenge to those of us who seek to interpret science to the disciples of these mass mediums is clear.

We seem to face a dilemma: we have found, we think, effective ways to tell about scientists' achieve-

(*Concluded on page 224*)

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SCIENCE PUBLICITY

(Concluded from page 222)

ments and to make science news take its rightful place in popular reading, listening, and viewing. Only the last doubters remain to be convinced of the obvious lesson that scientific enterprise pays dividends in a very practical way. But some of the techniques we have found most effective in making science interesting and readable to the nation's large nonscientist audience fail conspicuously to give a useful and constructive view of how science really works and what it really is. Indeed, some devices manage to reinforce, or even create, ideas which are absolute misconceptions.

If our experience to date with the traditional mediums of mass communication—newspapers and magazines—is at all conclusive, the outlook is not too favorable. While we have not exhausted the possibilities of the printed word, there is little promise of any revolutionary new ways for its use in treating scientific subjects.

Radio is much less explored; so are motion pictures. The documentary techniques of both have seen little use in serious efforts at communicating the methods and goals of science. In both instances there seems to be some reason for optimism and further explorations.

Still more exciting are the possibilities of television, which combines the power of sight and sound. If the potentialities of motion picture and radio are unexplored, those of television are unscratched: science subjects are only beginning to find their place before the cameras.

No one can say how effective the various mass mediums now available to us may be in conveying an honest picture of the whole of science to the new lay administrators of science. Nor is it safe to predict that we have, at our finger tips today, the most powerful mediums to render this service. What can be said with certainty is that those of us now serving in public relations posts for the promotion of science have a new job to do, quite without precedent. We confess to be unsure of how best to fulfill our new responsibilities. But we are sure that the case cannot rest on the accomplishments of the past 30 years.

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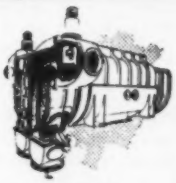

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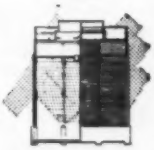

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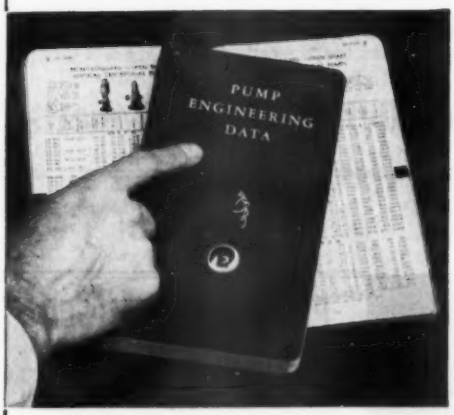

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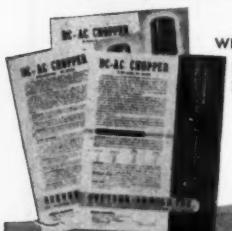

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FOLLOWING A COLD TRAIL

(*Continued from page 202*)

time, and then suddenly one or more seedlings may appear which differ in some important particular. Occasionally that sport or mutant is able to propagate and maintain itself as a new variety. Gradually, mutation has become accepted as an important component of evolution. It certainly accounts for much of what Darwin considered was caused by slow evolution.

A whole science has grown up concerning heredity, following Gregor Mendel's first discovery of its principles, and the later discovery of its physical basis. Cells increase by division, ordinarily into similar parts, which develop and increase, and so on. Occasionally, a mutation takes place, and the actual chromosomes, where the units of heredity occur, undergo change. Methods have been discovered which cause a great deal of speeding up of mutation. Exposure to many destructive forces, such as x-rays, heat, electronic radiation, or treatment with certain chemicals cause changes in the chromosomes, some of which are productive of stable new plants.[5] The most deep-seated and frequent mutations occur when the intensity of the destructive force is such as to result in about 50 per cent survival of the treated seed, pollen, or ovule. Treated seeds have to be sprouted and followed through several generations to find out what has happened, and particularly to note if the selected variants are fertile and produce true to type. Such experimental procedures are very slow and laborious and usually are utilized only to discover the laws of heredity and of plant susceptibility to change. Some

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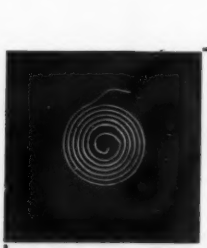

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plant breeders consider hybridization the greatest source of instability and variation. Richard B. Goldschmidt, the geneticist, in 1940, expressed the opinion that generally species of plants have developed by macromutation, however produced, and that no connecting links therefore may exist between them and their relatives. Most botanists feel, however, that this extreme view is unwarranted, and "heritable variations in plants are now generally believed to have arisen by mutation, to have been diffused by crossing and maintained by selection."[10] Mutations and other aspects of heredity, interesting as they are, concern only small areas at a time of botanical relationship.

Geographic distribution can be of value in grouping plants, especially in areas such as Australia, where a few families, such as the eucalypts and the Proteaceae, have evolved extensively over a long period of time without contact with the rest of the world.[1] Apparently, the cactus family so developed in the Americas, for none are endemic elsewhere. Even in a desert flora all that look like cacti are not always of that family, for other groups, such as the euphorbias, the milkweeds, and even the grapevine, can adopt succulence, spines, and other cactus peculiarities. The flowers and fruit, however, continue to show some of the family characteristics. Apparently, passage of northern genera to the south, via the tropics, or vice versa, is very difficult. Certain plants, however, such as the heaths, thrive on tropical highlands and might have made the trip from one temperate zone to the other via mountain chains. Even before Alfred Wegener announced his drifting-continent hypothesis in 1924, botanists had decided that the plants of the Southern Hemisphere might all have originated together a long while ago, and then become separated and some of the species evolved independently. Recent plant hunts in Fiji, New Caledonia, and other areas north and east of Australia, have produced new plants of great interest in an evolutionary way.[3] Some of these species appear to be transitional, on the track leading to the most primitive of the flowering plants. These new plants are all flowering plants in one sense, but have primitive ovaries and sometimes no pistils. A few species seem even to have *open ovaries*, so that technically they might not be classifiable as angiosperms (enclosed seeds). Further search for the ancestors of the angiosperms should still be productive in these geographic areas. Such a search could become a rewarding hobby for small groups of rich explorers seeking a unique activity.

(*Continued on page 228*)

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FOLLOWING A COLD TRAIL

(*Continued from page 227*)

The evidence points out that the monocots are sufficiently alike that they present a single relatively uniform phylum of interrelated species. Thus grass is related, more or less closely, to all the other monocots, including the lilies, the palms, and the orchids. All the monocots seem to have sprung from one original, self-perpetuating and onward-evolving monocot. The condition of monocotyledonism, also the patterns of the woody fibers, serves as a tracer to follow this great phylum, apart from all other vegetation. The original monocot appears to have evolved from the dicots scores of millions of years ago. No similarly discriminating characteristics label the dicots, which are quite various, but most botanists feel that it is possible that they, too, are monophyletic, that is, from one origin. The ancester of the dicots is still very obscure, but present inspired guesses are that it was a seed fern now long extinct.

At the End of the Trail

The present angiosperms are highly evolved plants, well suited to all conditions of climate and nutrition. The seed stage allows them to persist alive through such cold and drought as eventually must have killed off their predecessors, which did not have this flexibility. The seeds of the gymnosperms, which include the conifers, the ginkgoes, and the cycads were fairly effective in these same directions, but did not have the activities of insects to assist in their evolution, and

(*Concluded on page 230*)

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FOLLOWING A COLD TRAIL

(*Concluded from page 228*)

the plants evolved much less extensively. There is evidence of at least three great cycles of large plants (trees and herbs), each an improvement over the last in its ability to survive and develop. The present cycle is still evolving, and presumably is capable of much further advance. It supplies food and shelter to great numbers of the modern-type animals, including man. It is hard to imagine, but even angiosperms may some day be supplanted by still another cycle of plants different from but perhaps descended from them.

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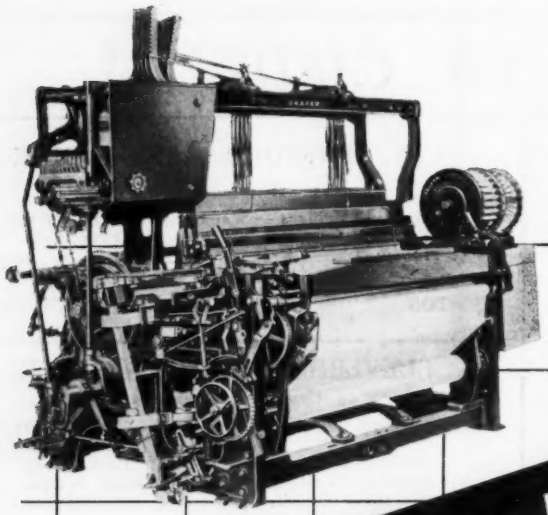

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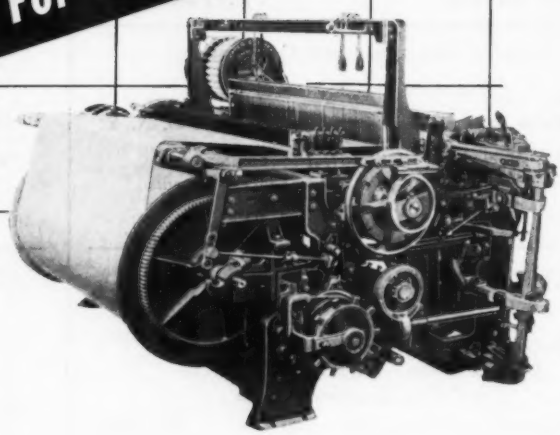

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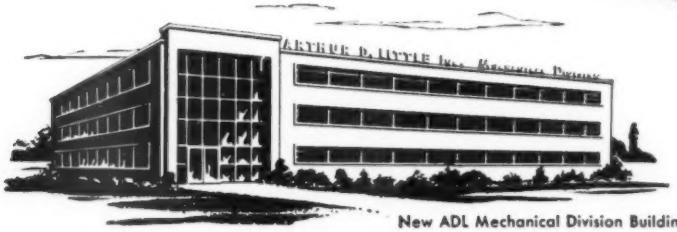

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